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COMPENSATION OF WORKMEN AND EFFICIENCY OF OPERATION.

By H. L. Gantt.

IV. FIXING HABITS OF INDUSTRY.

The preceding papers in Mr. Gantt's series, which began in our February issue, showed how the efficiency of workers under either day-work or piece-work systems of payment must be influenced by the mode of management and individual compensation adopted. They proceeded then to a demonstration of the effectiveness of the policy of an established "task and bonus," properly introduced and administered. The third article showed how the task and bonus could be properly determined and administered. We now pass to actual results secured in a variety of cases, under differing conditions, with all the essential detail of each workman's record. By graphic representation in two colors, the tendencies and the outcome (both individual and average) are made strikingly evident, while Mr. Gantt's own critical comment multiplies the value of the charts to every employer of labor. A concluding chapter next month will show the relation of these results to the great purpose of manufacture—Profits.

In answer to many inquiries we are glad to announce that Mr. Gantt's entire series, with much additional introductory matter and amplified comment, will be republished shortly in book form by THE ENGINEERING MAGAZINE.—THE EDITORS.

IN the pursuit of the study of the possibilities of performance by workmen, I have done much to train and educate them, and consequently have seen the far-reaching results that would follow if manufacturers in general would adopt a policy of educating and training the workmen they need. A paper on Training Workmen in Habits of Industry and Co-operation, read by me before The American Society of Mechanical Engineers in December, 1908, was written to explain the advantages of such a policy. Since that paper was written additional results have been obtained, which, when studied in detail, illustrate those advantages even more forcibly.

About five years ago I was engaged by a cotton mill to take up the question of making their labor more efficient, but as they were very conservative people we proceeded slowly. The superintendent and foremen were most of them English or Scotch, who were satisfied that the way they had done things in the old country was all right, and they objected to any change. The work proceeded very slowly indeed, but we gradually succeeded in getting our time and record system established and then a reliable cost system soon followed. We were, however, unable to do anything for a long time that had any great effect on the work itself, and after we had succeeded in getting the cost system in operation I told the treasurer that we had done about all that was possible under the conditions existing. The little that had been done, however, was so beneficial that in April, 1908, the treasurer asked me to come and finish up the job, saying that he now had a new superintendent who was in sympathy with the work, and that the worst foremen were gone.

During the year or more during which I had not visited the mill, attempts had been made to extend the work already started, but from lack of experience on the part of those engaged in it, practically no progress had been made.

When I took it up again my instructions were carried out conscientiously, and men detailed for the work were kept on it continuously.

Twelve new looms had recently been installed in the weave room, and as soon as a competent man could be got we began to study how to run these looms most efficiently. A pick counter was put on each loom, and the best weaver in the room (a Pole named Samtak) was given four of them to run.

A trained observer with a stop watch stood by the weaver and studied all his motions in detail. He learned how this skilful weaver stopped and started his loom, how he removed the empty bobbin from the shuttle and put a new one in, how he tied the knot. From these observations he found out how much time it was necessary for the loom to be stopped in a day, and consequently what proportion of the time it should be actually weaving. No time was allowed for "loom out of order," or "no filling," or any other cause that might be eliminated. Steps were taken to be sure that the loom was in good order and that proper filling should always be on hand, and a task was set on the supposition that all removable obstacles would be removed. This task was fixed as the number of picks the loom should throw provided these unnecessary delays were eliminated, and a sub-

stantial bonus was offered for its accomplishment. It was expressed as a percentage of the total number of picks the loom would throw if it ran constantly all day without any stop. It is interesting to note that the task was greater than the best weaver had been able to accomplish regularly before we had made special provision to remove the obstacles. Having decided upon the task, three of the next best weavers in the room were chosen to do it and Samtak was the instructor to teach them how.

The three men chosen are those whose names are at the top of Chart I (facing page 164). They were all Greeks, speaking almost no English. The instructor, Samtak, is a Pole, whose English is not very good, and who could make himself intelligible to the Greeks only by signs. The first man, Papadimitri, declined to work under instructions and on task work. He was not discharged but allowed to work his own way until he should see where his interest lay. We therefore had Samtak give all of his attention to the other two, our observer, who had studied Samtak's work, being constantly on hand keeping a record of the number of picks each loom threw per hour, and removing the obstacles to the men's performing the task. Both men failed to earn a bonus on the first day—this is shown by the red mark—but on the next two days they came so near it that it was allowed them, and they got a black mark.

Our observer, however, satisfied himself that failure to perform the task was due to the fact that the warps and filling were not coming in a satisfactory manner, and that some of the looms were not just right. He accordingly ceased for a time to urge the men to perform the task and devoted his attention to getting things in such a condition that these obstacles would be removed. The black cross shows that the men were on day work and were making no special effort to perform a task. At the end of eleven days our observer felt that conditions were all right and he started the men again. Papadimitri by this time had concluded that we were going to "play fair" and wanted to start too. The black lines on the chart show how soon all began to make their bonus pretty regularly.

It was necessary, however, for our observer to be constantly on hand and to keep a record of their work hour by hour, for he would frequently find some loom falling behind, which, if not looked after would cause the weaver to lose his bonus. Whenever he found a loom not doing all it should he called Samtak's attention to it, with the result that the cause was soon discovered and removed; but Samtak seldom at first noticed a lagging loom. Again, Samtak was at

first very slow at making any complaint if anything was wrong, but the example of our instructor and the incentive of a bonus of 6 cents for each weaver who made his bonus, and 10 cents each if *all* made bonus, gradually taught him to look out for their interests and his own. It took the entire time of our observer for several weeks to get the conditions such that no obstacle would arise which Samtak could not remove. It must be remembered that while Samtak was a good weaver, he was not a teacher. He had in the past been trained not to object when things went wrong, but to do the best he could without complaining. Even with the example of the instructor and the incentive of a bonus, it was some time before he realized that we really intended that he should assert himself.

We began to study the looms about the first of June, and started the first task workers early in July, but it was nearly the middle of August before we were ready to start others on task work. By this time other weavers were willing to try, but it required the attention of both Samtak and our observer to get these men going right. It took the first two of these men about three weeks to become skilful enough to do the task, but the third, fourth and fifth did it from the start. During September and October we put on several more who gradually became proficient.

By this time we had gotten all of the best weavers on task work, and henceforth we had to train the poorer ones, which partially accounts for the sudden increase of red marks. Another cause for this increase was the fact that several trained weavers left. They had not yet become convinced that we were going to treat them fairly, and left for some insignificant cause. The dropping out of these men shows the importance of time in doing this work. Until the workmen become thoroughly satisfied through their own experience that the job they have is the best one they can get, they may be stampeded by a very slight cause.

Our gang had now become too large for Samtak, whose allotment was twelve weavers; and we started another gang, placing in charge of it the weaver Shea, whose name indicates his nationality. He was the only bonus weaver who could speak English.

While there are some exceptions the chart has a tendency to become blacker slowly as time progresses.

Chart II* shows the record of Samtak's gang from March 1 to October 9, 1909. This chart distinctly blackens as time progresses. This means more than that the men have acquired the skill to do the work. They have acquired the habit of working steadily and keeping

* Chart II is placed below Chart I, on the same sheet, facing this page.

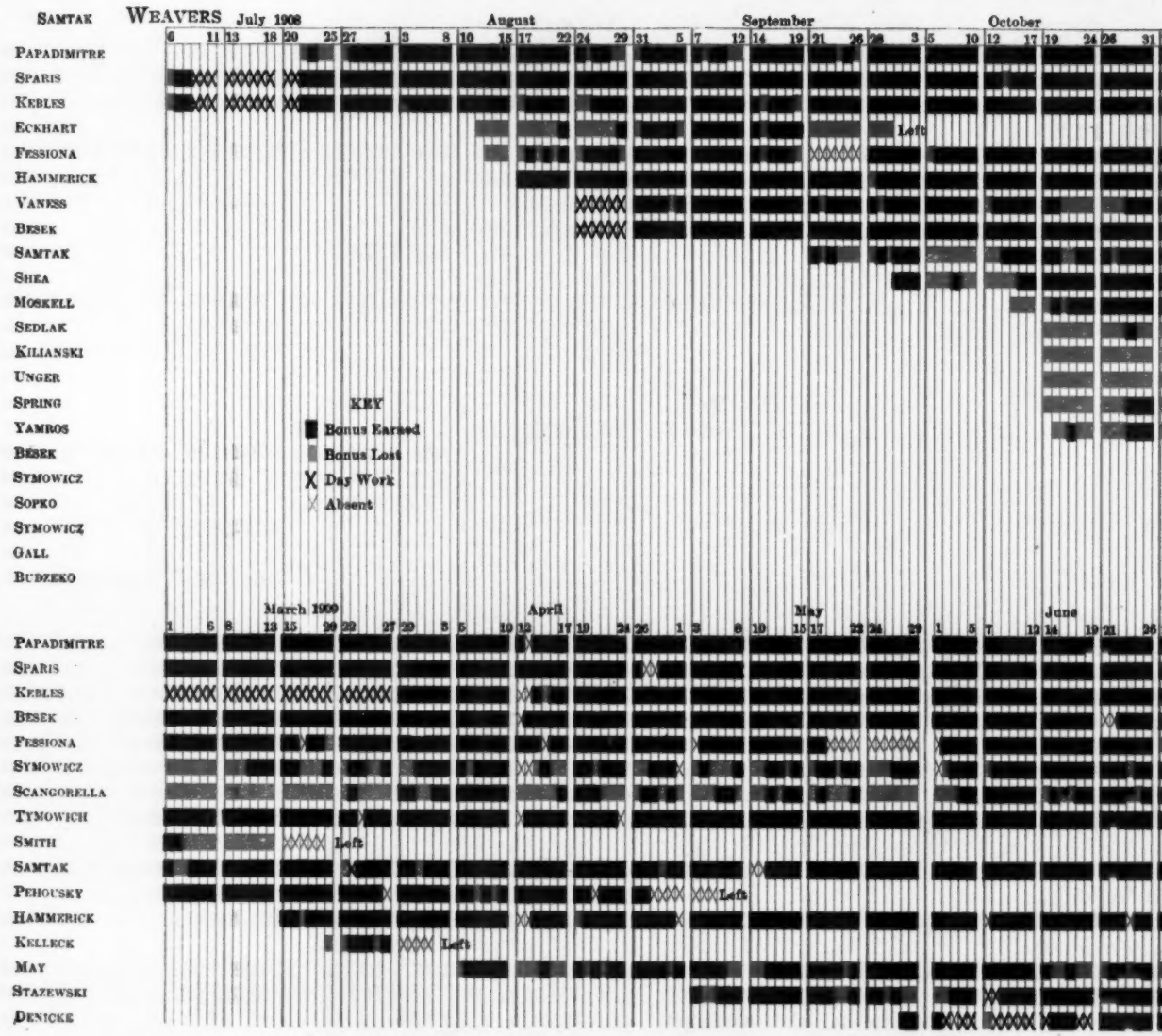
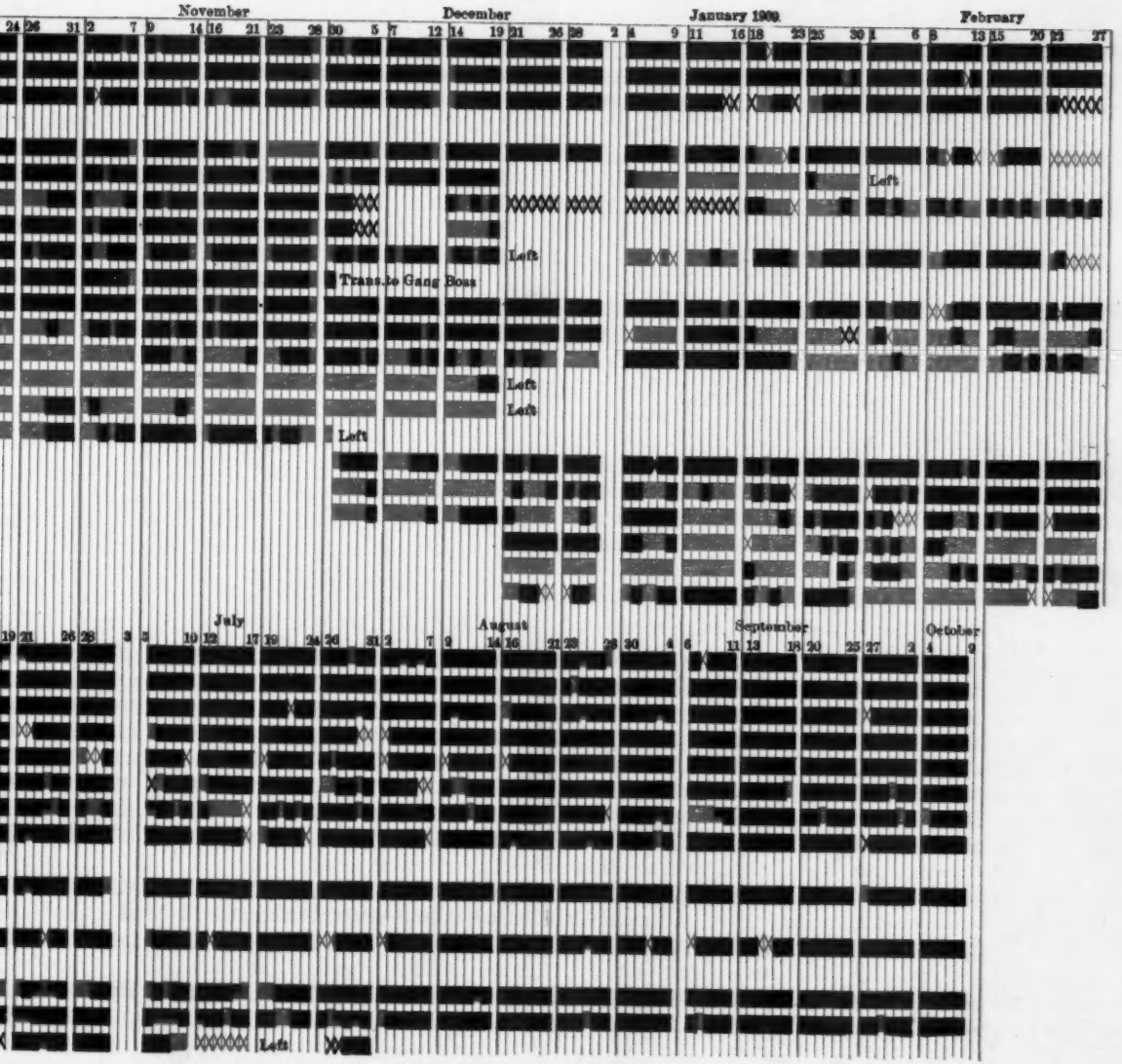


CHART I. TASK AND BONUS SYSTEM IN A WEAVE ROOM. NOTE THE INCREASE OF BLACK (MEANING TASK ACHIEVED AND E
CHART. II. THE RECORD OF THE SAME ROOM CONTINUED THROUGH THE FOLLOWING EIGHT MONTHS. THE HABIT OF INDUSTRY



ED AND BONUS EARNED) AS TIME PROGRESSES.
INDUSTRY HAS BECOME FIXED.

their attention on their work. The red crosses signifying absence are notably lessened. These men have not only improved in skill, but in habits of industry; and the gang boss Samtak is not their driver, but their helper and friend. The blackening of the chart signifies not only that more work is done, but that it is done better, for *black* means that both quantity and quality are up to the standard. There is one man in the group whose history is worth studying, namely the weaver Samtak, brother of the gang boss. Note that he began on this work on September 21, 1908. He was a good weaver who had been working in the mill off and on for several years. His temper is such that he was liable to leave on the slightest pretext, but in a few weeks or months would come back for a job, probably having left his new job for some similar slight cause.

He would not do task work at first, although offered a chance, but took hold when he found others profiting from it. The old habit, however, of quitting on a slight pretext was still on him, and he left before Christmas. By the first of the year he was back, but he had lost his ability to make his bonus, and he spent nearly two weeks before he earned it a single time. Note also that he was absent three days in the first two weeks. Was he again looking for another job? His actions during this time indicate an unsettled frame of mind. Again in the latter part of February the *wanderlust* came over him. Early in May he again had a slight attack, possibly of "spring fever." Since that time he seems to be entirely cured.

We knew this man and understood his moods, and we know what kind of a change has taken place. Have not many others been influenced in the same manner?

In considering this work an important element to be noted is the time needed. When we began our study in June, 1908, we already had in operation means for learning how long each worker spent on every job and how much work was done. There was also in existence a system of laying out the work from the office. In other words, the general mechanism of our system was in operation and working smoothly, yet it was several months before we got enough task work going to make any real show. If we had attempted to introduce it much faster we should have met with two difficulties. First, it would have been impossible for us to remove all the obstacles for a large number of weavers. Second, the poor weavers would probably have persuaded the good ones not to try to do as we wished. The best evidence of this is that Papadimitri, one of the very best weavers, declined to do the work at first.

Time is needed to overcome prejudice and to change habits. This is a psychological law, and its violation produces failure, just as surely as the violation of the laws of physics or chemistry.

Chart III* represents our progress in training workers to do their task in winding weaving bobbins—bobbins of filling that go into the shuttles. Each operative tends a number of spindles, and the work consists first of taking out full bobbins and putting empty ones in place; second, removing empty spools from which the yarn has been taken, and replacing them with full spools. In as much as the machine runs at a constant speed, the bobbins fill and the spools empty more rapidly with coarse yarn than with fine; hence it was necessary to make a careful detail study of the subject to set a proper task for different sizes of yarn. This study took about six weeks, and having settled upon proper tasks, we started a girl named Wagner on task work early in February. She would not do it at first but staid home for a week. At the end of that time she came to work willing to do as we wished, and was evidently surprised at the ease with which she succeeded. On March 1 we began to keep the charts. At that time those doing the task as shown by the chart represented but a small proportion of the whole number of workers. Our gang boss, McCabe, received 5 cents for each worker that made a bonus and 10 cents each if all made it. Our observer was constantly on hand, at first, to help him remove obstacles, and to see that the workers had every opportunity to work efficiently. In spite of this a large proportion of the first ones failed to earn the bonus regularly and gradually left. Many of these were girls who evidently found continuous attention to their work irksome, and even though they were capable of doing the work, preferred the more free and easy method to which they had been accustomed. Others showed but little ability to do the work or to learn. The fact, however, which is evident from the chart —that the larger the number of bonus workers in the mill, the faster the new ones learned—is a matter of great psychological importance. *There is in every workroom a fashion, or habit of work, and the new worker follows that fashion, for it isn't respectable not to.* The man or woman who ignores fashion does not get much pleasure from associating with those that follow it, and the new member consequently tries to fall in with the sentiment of the community. Our chart shows that the stronger the sentiment in favor of industry is, the harder the new member tries and the sooner he succeeds. We must therefore make our compensation such as to encourage the habit, or fashion, of industry; and our charts show to what extent we have succeeded in fixing this habit.

* Chart III is inserted between pages 168 and 169.

It is interesting to note that although failures most frequently occurred on Monday, even this habit could be cured.

The mill shut down for about three days about July 4 to take stock, and as we had just gotten this room in good shape, that little vacation may be used as a dividing line on this chart. Remembering that solid black indicates that the full amount of work has been done, and that all of it was up to standard for quality, while solid red represents that the work was below standard either for quantity or quality, and sometimes for both; also that the black cross means the worker was doing day work, while the red cross means that the worker was absent, the amount of black on any day is a measure of efficiency for that day and the red is a very accurate measure of the amount of supervision needed, for all cases of failure to perform the task must be investigated, and all cases of absenteeism should be inquired into. The gradual change of the chart from red to black means not only that the workers are becoming more skilful and regular in their habits, but that the machinery is being kept in better order, for the task is so set that unless the machines are in good condition the bonus cannot be earned.

Since July 4, not only has the amount of supervision needed been diminished and a regular output maintained, but the workmen been much more regular in attendance and none have left. The indications of the chart are that the output of the room since July 4 has been larger, better and more uniform. It is now easy to predict the daily output and to make promises of delivery that will be kept without special effort on the part of the foreman. Before July 4 such predictions were only estimates, and a proper output was kept up only by constant supervision. As the gang boss in this room gets a bonus of 5 cents for each worker who earns a bonus, and 10 cents each if all earn bonus, it is easy to see that the superintendent does not have to worry much either about the quantity or quality of the product. It is easy to measure the quantity, and the quality is taken care of more easily still, for the weaver who gets poor bobbins refuses to use them.

Chart IV* represents girls winding yarn on spools. Note that it was the fashion among these not to try for the bonus on Saturday. Most of them could earn it every day if they chose, but there was evidently a feeling against working hard on Saturday.

Note that on March 6 two girls tried to break this precedent, but it was too strong, and on March 13 all failed. On March 20 another tried. On March 27 one of the first two tried again, but after that all gave it up for three weeks. Then our first two evidently decided that

* Charts IV and V, on one sheet, are inserted between pages 172 and 173.

they would defy public opinion, which they did pretty successfully until June 6, when apparently by common consent all "took it easy." After that, however, all gradually fell into line and the Saturday inefficiency disappeared as did the Monday inefficiency on Chart III.

Chart V* represents girls inspecting cloth and mending slight defects in weaving, trimming ends, etc. This is high-grade work and all defects must be eliminated. We started the task after careful study, and while most the girls showed the ability to perform the task only two did it with any degree of regularity. On April 7 three left because they were unwilling to maintain the high standard of quality that had been set. The chart shows the difficulty of getting new ones to do the work. Fortunately the three dissatisfied ones came back for their jobs in a few days, and soon became better than ever. These inspectors were supplied with work and had the heavy cloth handled for them by the three men whose names are at the top of the chart. Each of these men received two cents for each girl that made a bonus. Early in July it was decided to give the boss weaver, who has not yet been mentioned, a bonus. He is an excellent man and was undoubtedly doing his work well, but we felt that his bonus should depend upon the quality of the work turned out. In as much as the better the cloth was when it came from the weaving room, the easier the task of the inspectors would be, we decided to make his bonus in proportion to the number of inspectors that earned theirs. The inspectors at once began to earn bonus with great regularity, for the boss weaver found that the inspectors were only too anxious to point out defects which it was to his interest to have corrected. He visits the inspecting room frequently during each day, and by the reports he gets keeps closely in touch with what his weavers are doing. The result is a continuous improvement in the quality of their work.

Taking all of these charts together we note the following: That the amount of supervision needed has diminished; that the quality of the work is better; that the quantity is greater; that the amount being turned out can be predicted accurately, and hence promises need no longer be guesses, but can be made and kept; that the workers are not only earning more money, but are acquiring better habits of work which will make them better citizens.

Chart VI (page 170) shows actual results in task work that has been going on for over two years, showing increase in output and decrease in cost. Charts similar to Charts I to V were kept for most of this work while it was being installed, and they show characteristics identical with those displayed on the charts here given. They carry

* Facing page 172, on lower half of sheet.

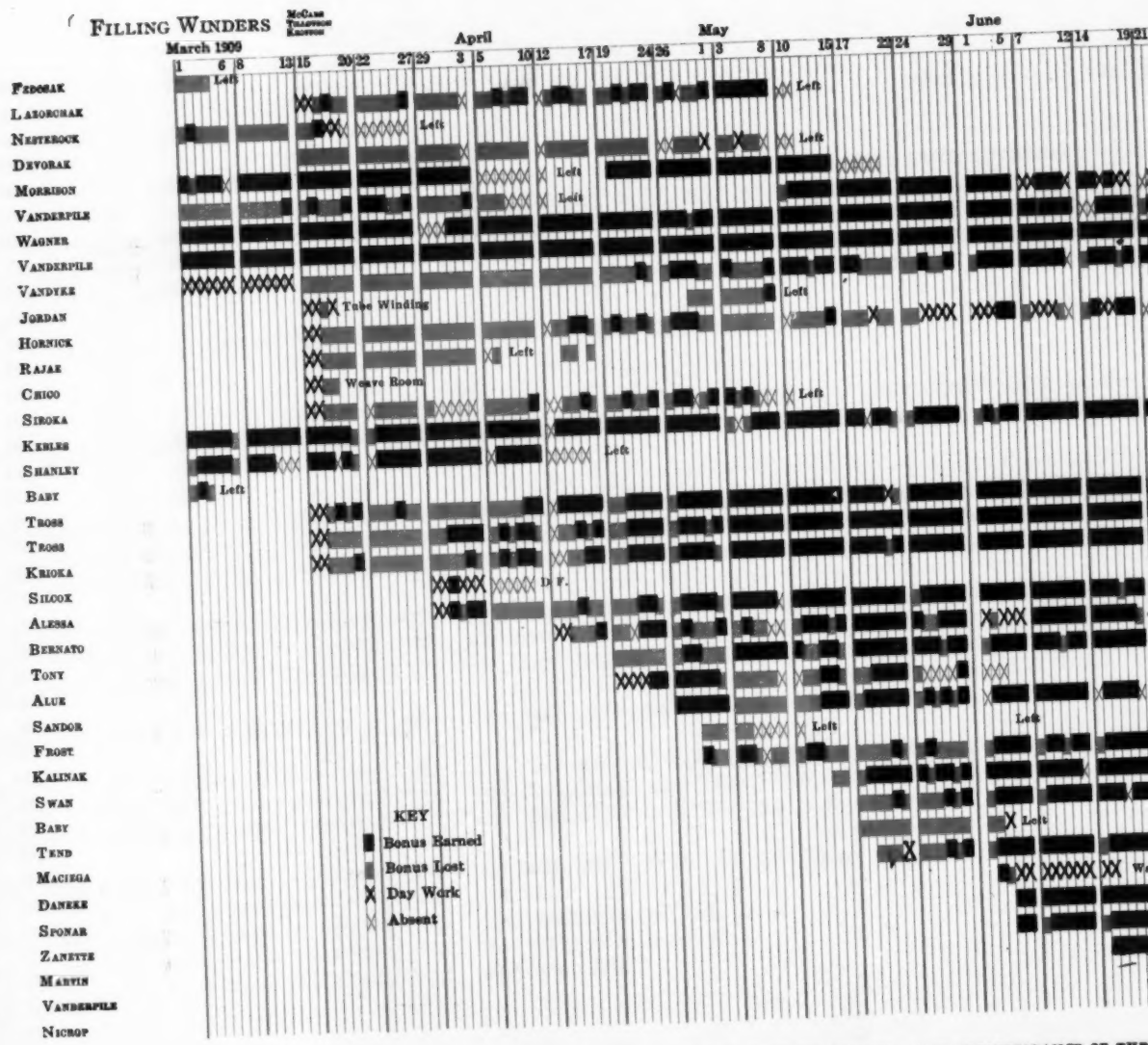
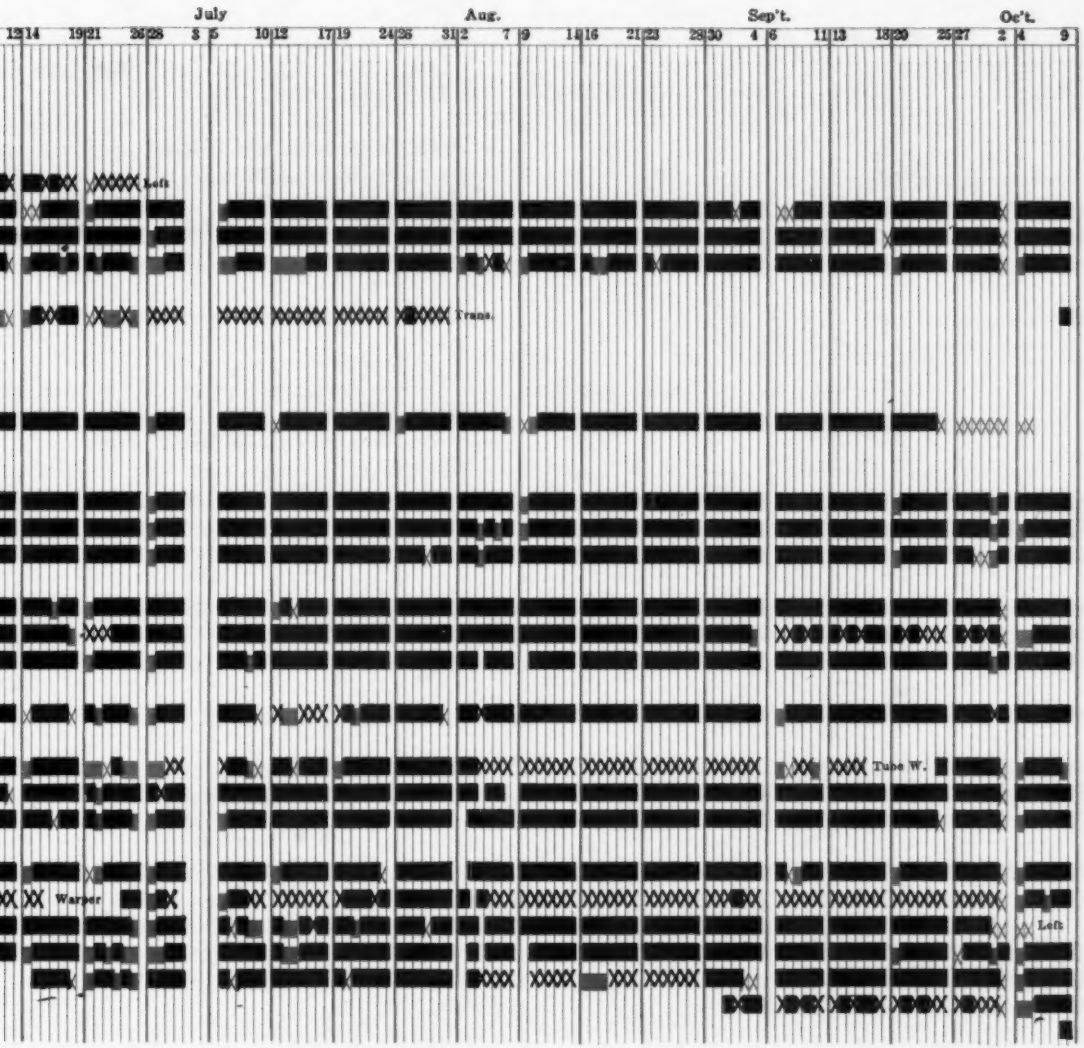


CHART III. TASK AND BONUS RECORD OF WORKERS WINDING WEAVING BOBBINS. NOTE DISAPPEARANCE OF THE



OF THE HABIT OF SLACK WORK ON MONDAYS.

the records of nearly 100 people, men and women, chiefly New Englanders or French Canadians.

In this chart the heavy line marked 100 represents the output per operative and the wage cost per unit of product before we began to study the problem. Figure 1 on this chart represents the various operations in bleaching, finishing, and putting up sheeting. The ordinates of the upper heavy line measured from the base line marked 0 represent the present output per worker compared with the former output of unity, an average increase of about 80 per cent. The broken line represents the present average wages, about 40 per cent greater than the former wages. The lower full line represents the new wage cost per piece, which averages only about 60 per cent of the former wage cost. In other words, we are getting an increase in output of 80 per cent and each unit costs us only 60 per cent of what it did before. Our charts have already made it clear that the supervision needed is less, hence the profits have actually increased to a much greater degree than the charts indicate.

Figures 2, 3 and 4 on this same chart illustrate even more forcibly the effect of task work with a bonus, for in these cases the average output is in all cases more than double, and in one, the manufacture of pillow cases, more than three times as great.

The increase in the case of the pillow-case factory was so great as to indicate that the work must have been done very inefficiently before. This was undoubtedly true, but probably not more inefficiently than in many shops run by a foreman who has no special training as an executive, and of whom much more is expected than he could possibly do efficiently.

But this is not all; a fortunate set of conditions enabled us to get a measure of the improvement in quality which had been obtained. Soon after the reorganization of the pillow-case factory represented in Figure 4 on this chart got well under way, there was a serious complaint of bad work from one of the largest customers. An investigation proved that the complaint was well founded, and the customer was asked to return all the goods.

About fifty cases of goods were returned, and of course the bad work was all blamed on the new system. The inspection of the first few cases proved that the number of imperfections per case varied greatly, and it was decided to keep an exact record of what the imperfections in each case were, and whether the work was done before or after the installation of the task and bonus system. The result was as follows: In 28 cases of goods done before task work was started,

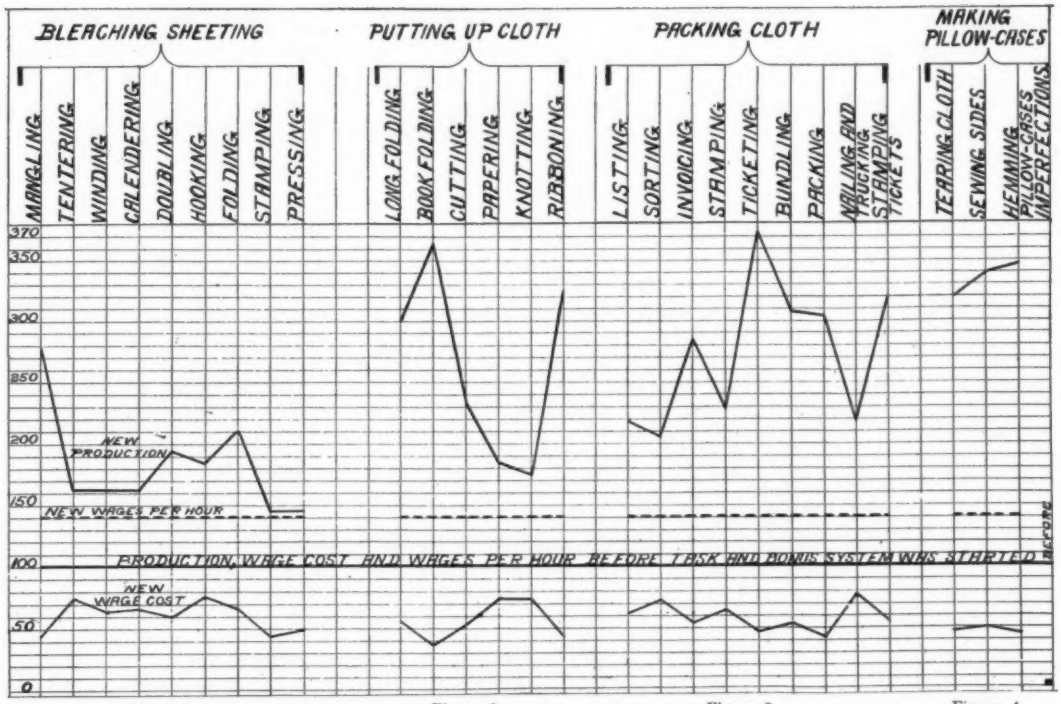


Figure 1 Figure 2 Figure 3 Figure 4

CHART VI. ACTUAL RESULTS UNDER THE "TASK AND BONUS" SYSTEM AFTER MORE THAN TWO YEARS OPERATION.

The solid line represents the regular average volume of production, wage cost per unit of product, and wage rate per hour before the system was introduced. On this as unity for each of these scales, the dotted and broken lines represent the conditions more than two years later. It will be noted that the new wage rate per hour is about 140 per cent of the old; the production has risen to a level from 155 to 375 per cent of the old; the wage cost per unit has fallen to about 60 per cent (ranging from 38 to 75 in different operations) of the old cost.

the average number of imperfections per case was 47½. In two cases done after the task work was started, but before the inspection was going properly, the average number of imperfections per case was 2. In eleven cases done under the task and bonus system after the inspection was going properly, the number of imperfections per case was less than one.

Representing by unity in Figure 4 the number of imperfections per case before the task and bonus system was started, the short line represents the number afterward—less than 2 per cent.

This improvement in quality also points to the fact that the pillow-case factory was badly run; the interesting fact is that it was possible to make such a great improvement in a few weeks.

The next question that naturally comes to one's mind is that of the permanence of these results. On this subject we have some data also.

About six years ago we began the reorganization of a packing-box factory, which made five or six hundred cases per day and was run in connection with two large bleacheries of cotton cloth. This factory had been a sore spot, and whenever shipments were delayed the box factory came in for its share of the blame. It took nearly a year to get this factory into shape, but for the past five years it has run so smoothly that the manager of the bleachery has hardly been aware of its existence. Two years ago they had in this factory seventeen bonus workers; now they have nineteen bonus workers out of a total of thirty workers.

The organization of one of the bleacheries referred to was practically completed on these lines over two years ago, and it is running today better than it did then. The management of the other bleachery is gradually being remodeled on the same lines.

The management of the pad dyeing department of a large dye works has been remodeled on these lines, with the result of practically doubling the output and distinctly improving the quality. The workmen are getting much better wages, and the costs are decidedly lower. This department has been running on these lines over a year, and is running much better today than at any time yet.

No better testimonial both to the quality of the work done and the economy with which it is being done can be had than the fact that, notwithstanding the increased output per machine, they have been obliged to add other machines to the dye works to take care of the business offered, until they are doing in this department today nearly three times what they did two years ago.

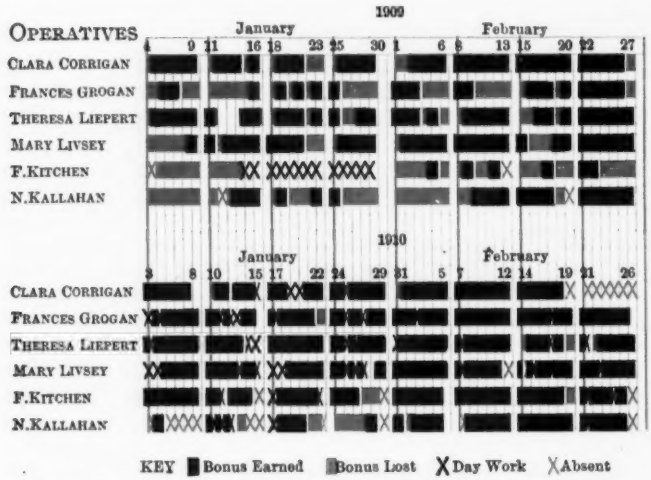


CHART VII. BONUS RECORD OF GIRLS WORKING IN A FOLDING ROOM.

The upper half shows eight weeks in 1909. The lower half, the corresponding 8 weeks in 1910. Remembering that red means bonus lost and black bonus earned, the improvement in 12 months becomes strikingly apparent.

Chart VII represents girls working in the folding room of a bleachery—not one of those previously referred to—and is interesting from the fact that they belong to an entirely different class of people from those in the cotton mill (as can be seen by their names), and also from the fact that some of these girls have often as many as ten or fifteen different kinds of work per day. In starting this group, which is much larger than the number shown here, we had exactly the same experience as with the weavers and the winders; one of the girls declined to do as we wished at first, and afterwards became one of our best workers. These three cases illustrate the fact that a worker may hesitate, or even refuse to do work by a new method, and still become ultimately a good and loyal worker under the new methods. The action of a workman when brought up against a new method is largely influenced by his temperament, or the opinions of his friends. When, however, this method has been established all the evidence available goes to show that these results are not only permanent, but that the workers become more proficient and the product better. This chart shows the improvement after a year's training. We began the task and bonus in November, 1908. The

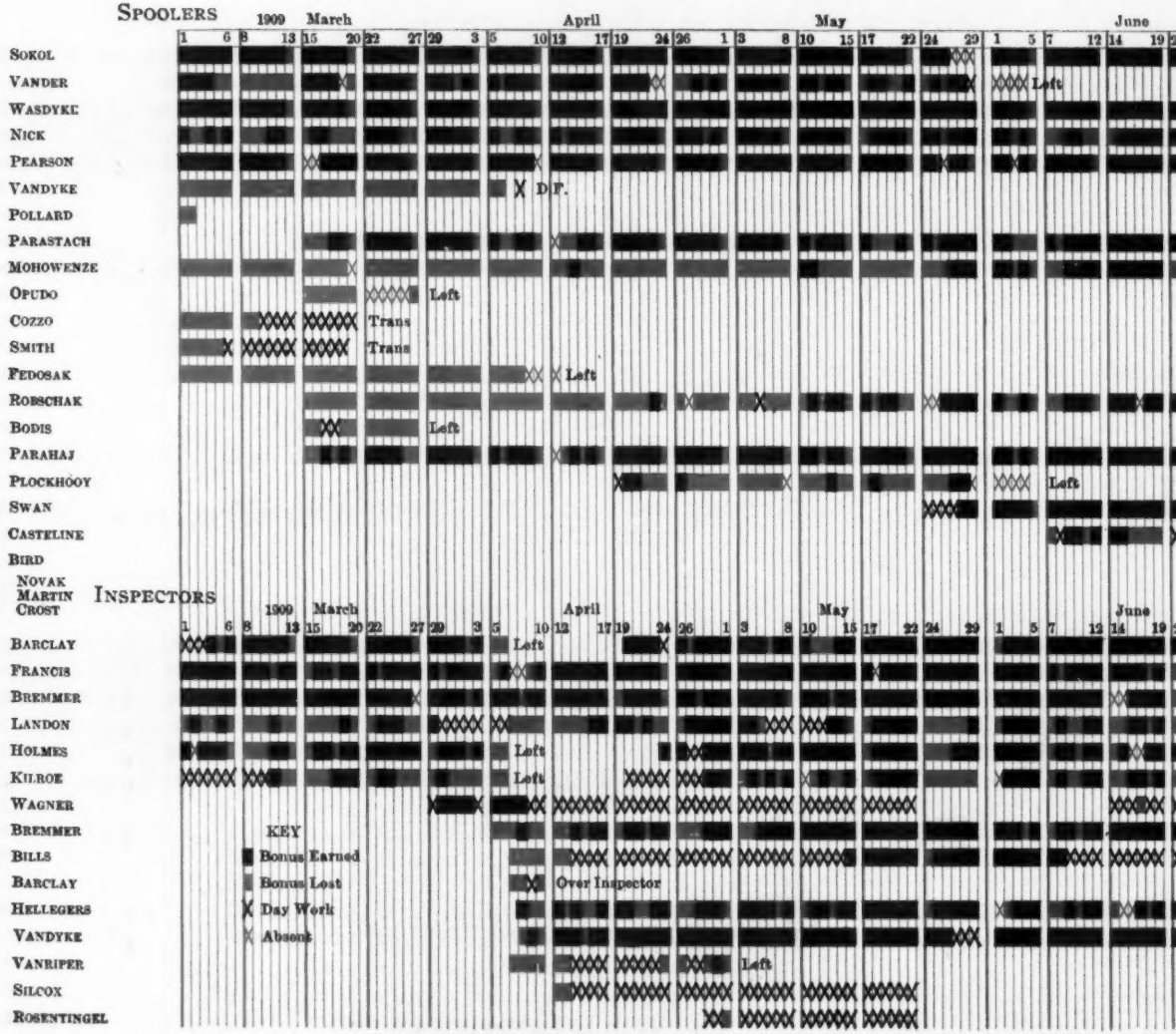
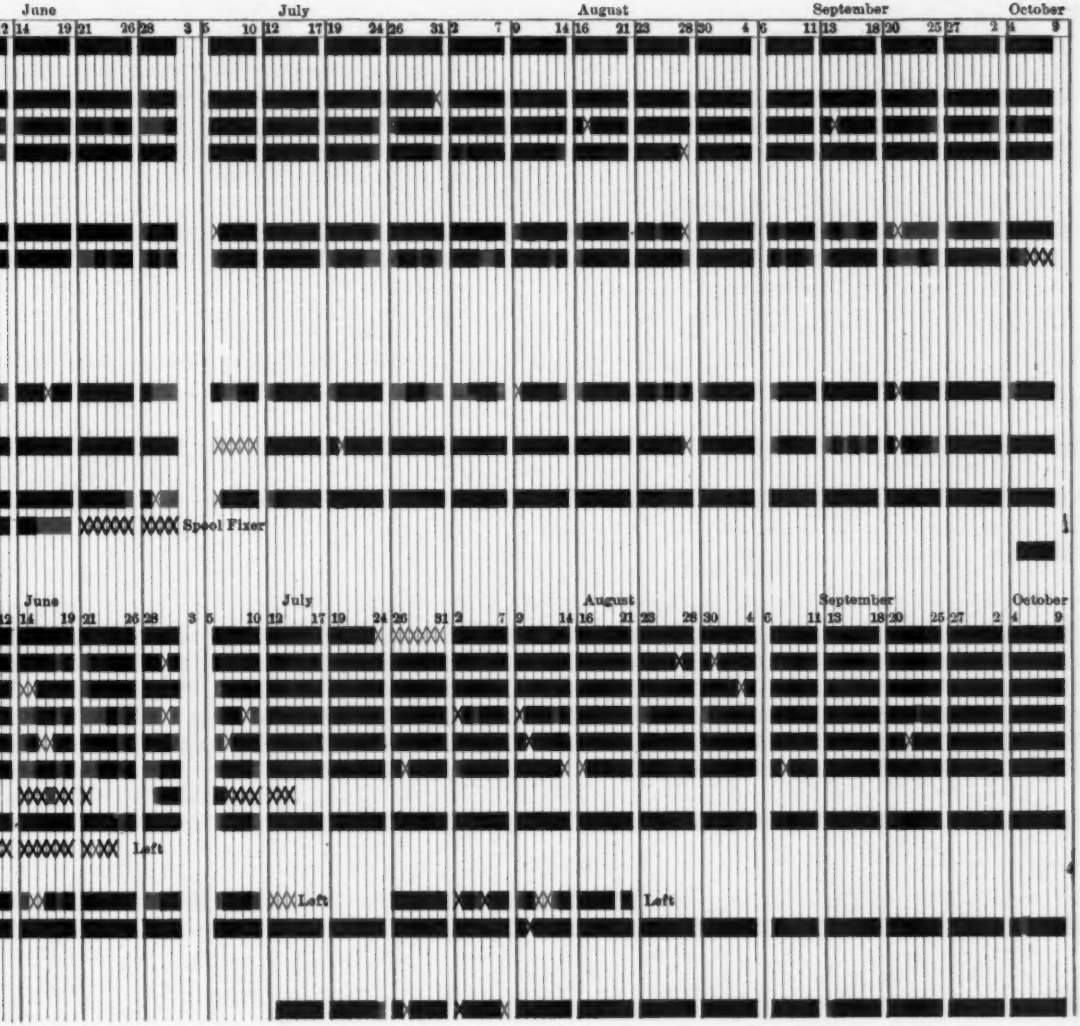


CHART IV. TASK AND BONUS RECORD OF GIRLS WINDING YARN ON SPOOLS. NOTE DISAPPEARANCE OF SLACK-SATURI

CHART V. TASK AND BONUS RECORD OF CLOTH INSPECTORS AND MENDERS. NOTE IMPROVEMENT FOLLOWING ESTABI



CK-SATURDAY HABIT.

NG ESTABLISHMENT OF BONUS TO HEAD WEAVER EARLY IN JULY.

upper section of the chart shows how the girls worked about the time the system got well started. The lower section is a record of the same girls a year later.

CO-OPERATION.—A careful analysis will show that we have established a system of co-operation, where it is to the interest of each bonus worker to do as much work as he can, and to do it as well as possible. Further, if a workman does poor work, others suffer beside himself, with the result that he either learns to do good work or finds work elsewhere. As it is to the interest of the worker to do good work, and plenty of it, he contracts the habit of doing a large amount of good work. As long as it is to his financial interest he will continue to cultivate this habit.

There are only four ways in which such a system can go to pieces.

The first way, and the one most liable to happen, is by a change of management, by which the men in authority who have been trained under these methods are replaced by men not so trained. Such men might destroy the whole structure before they knew what they were doing. This was done to a large extent at the Bethlehem Steel Works.

The second is by a desire on the part of the management to get work done more cheaply still. In this case they might do great harm by cutting wages, or increasing tasks. In as much, however, as under this system they can get work done more cheaply than their competitors can do it, they have so far been willing as a rule to let the workmen have fair wages, especially when they realize how much harder it will be to train up a new set of workmen at lower wages or more difficult tasks.

Chart V shows in a marked manner the effect of losing a few skilled workers.

The third way is for the workers to demand more wages. In as much as they are making more wages in a mill run this way than they can get elsewhere, this is not liable to happen.

The fourth way is for the business to fall off to such an extent as to give no work. Here again the plant operated in this manner will hold out longest, for costs are lower. It is also a fact, shown by experience, that if there is an increase of work it can be provided for much more readily under this system, where our trained men are capable of teaching.

While this discussion is of importance to the man considering the adoption of these methods, the most important fact for people in general is that our immigrants as well as our native people can

be trained to habits of industry and made efficient, and that a scheme of co-operation can be devised that is beneficial alike to employer and employee. Further, it is of importance that when once in operation these methods are continued and perfected by the workers themselves.

If these methods were introduced extensively, it is without question that the habit of the shop would influence that of the community, and there would be a general increase in efficiency. The habits a man has to acquire to become efficient in one class of work stand him in good stead in becoming efficient in other work. These habits of work are vastly more important than the work itself, for it is our experience that a man who has become efficient in one thing, readily learns to become efficient at doing other things. The ability of such people to produce wealth is more to the country than the wealth itself. The productive power is more valuable than the product. Many of the workers represented on our charts are immigrants who cannot speak English, yet in a few months at most they become far more efficient than the average mill operative, who professes to be skilled.

It must be emphasized, however, that this training was done only by the very best workers under the direction of good teachers, that the individual was given the personal attention, day after day, of the teacher and the expert workman, and that he was assured of good compensation if he succeeded. We concentrate on the individual, but when a few have learned, and are being benefited, others are not slow to imitate. One cannot learn to do this work by reading magazine articles; it must be learned in the shop where an educated man studies the work and the workmen. When he has become familiar with both work and workmen he can make a start, but to try to do much without this kind of practical experience is about as futile as trying to learn to skate through a correspondence school.

To succeed in this work the teacher must have the ability to analyze and investigate, and must himself be trained in such habits of industry and concentration as to enable him to become master of his subject.

In his inaugural address, President Lowell, of Harvard University, emphasized the importance of hard and accurate thought in the following words:

"The student ought to be trained to *hard and accurate thought*, and this will not come from surveying the principles of many sub-

jects. It requires a mastery of something acquired by continuous application."

If we substitute for *hard and accurate thought, hard and accurate work,* his remarks are just as true when applied to the workmen as to the student. The workman who has become master of something takes pride in his work and soon distinctly improves in personal appearance. The improvement is so universal and so marked as to be always distinctly recognizable, and is much more than can be accounted for by the increase in wages which enables him to dress better.

This improvement is even more marked in girls than in men, for the girls invariably acquire a better color and improve in health. In one case the girl bonus workers formed a society and adopted a badge which they all wore. Only those who could earn their bonus were eligible. This incident is a little thing in itself, but it shows the feeling that comes with mastery of some subject. They know what they can do and are proud of it. This consciousness of efficiency, this knowledge that they have succeeded and can do it again, puts the worker in a very different class from those who go along day after day watching the clock and doing just enough not to get discharged.

The task gives the worker a definite object to strive for, causes a certain amount of mental exhilaration, and invariably increases the keenness of the perceptions.

From our task workers we frequently get instructors and sometimes investigators. From our investigators and instructors we get an ample supply of superintendents and foremen. The foremen and superintendents trained under this system have proved far more successful than any it was possible to hire.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

II. HEAD-RACES, PRESSURE PIPES, AND PENSTOCKS.

This is the second article in Mr. Koester's series; the first installment, published in April, was concerned with the impounding of water supplies and the engineering construction necessary to that end. The purpose is not to instruct the specialist in hydro-electric engineering. It is to provide a clear and concise statement of the fundamentals of established practice in this field for the use of others who may be interested, either as practitioners in other provinces of engineering, as owners or managers of power-using installations that may be electrically operated, as providers or purchasers of machinery for some part of the equipment, or as commercial or financial participants in some development involving the utilization of water power.—THE EDITORS.

WHILE some hydroelectric plants require a dam only, from which the water is conveyed by means of pressure pipes or penstocks to the power house, others require a head race for bringing the water from upstream to a collecting basin, from which the penstocks lead to the turbines in the power house. The head race may be a flume, trench, canal, or tunnel.

Flumes are made either of masonry or planking. The largest use of wooden flumes is in the western States and on the Pacific coast. They are constructed of California fir, redwood, or Oregon pine, and carried on trestle-work or on concrete piers. They are usually of the open type and built on a slope of ½ to 1 foot in 1,000. The planking must be laid so as to break joints, the flumes must be water-tight, and the wetted perimeter must be smooth to allow a velocity of 7 to 8 feet per second. Where flumes run along mountain slopes they should be provided with some means of protection against sliding earth or loose boulders, which may be done either by covering the flume and placing on top at least two feet of earth, which acts as a cushion, or by building on the mountain side of the flume a retaining wall of sufficient height to deflect the boulders across it.

The common form of canal is a trench dug in the soil and the sides sloped, depending upon the firmness of the soil, usually 1 : 1. The velocity chosen depends upon the character of the soil. The table on the following page gives the velocities which are safe and also the mean velocities.

VELOCITY OF WATER IN CHANNELS.

Material of channels.	Safe bottom velocity in feet per second.	Mean velocity in feet per second.
Soft brown earth.....	0.249	0.328
Soft loam.....	0.499	0.656
Sand	1.000	1.312
Gravel	1.998	2.625
Pebbles	2.999	3.938
Broken stone, flint.....	4.003	5.570
Conglomerate, soft slate...	4.988	6.564
Stratified rock.....	6.006	8.204
Hard rock.....	10.009	13.127

The lowest velocity is found in the wetted perimeter, and according to Rankine the different velocities are in the ratio of 2 : 3 : 4 in low-velocity canals, and 3 : 4 : 5 in high velocity canals. The greatest velocity is found in the middle slightly below the surface of the water.

The following figures are selected from a diagram by W. A. Burr in *Engineering News*, Feb. 8, 1894:

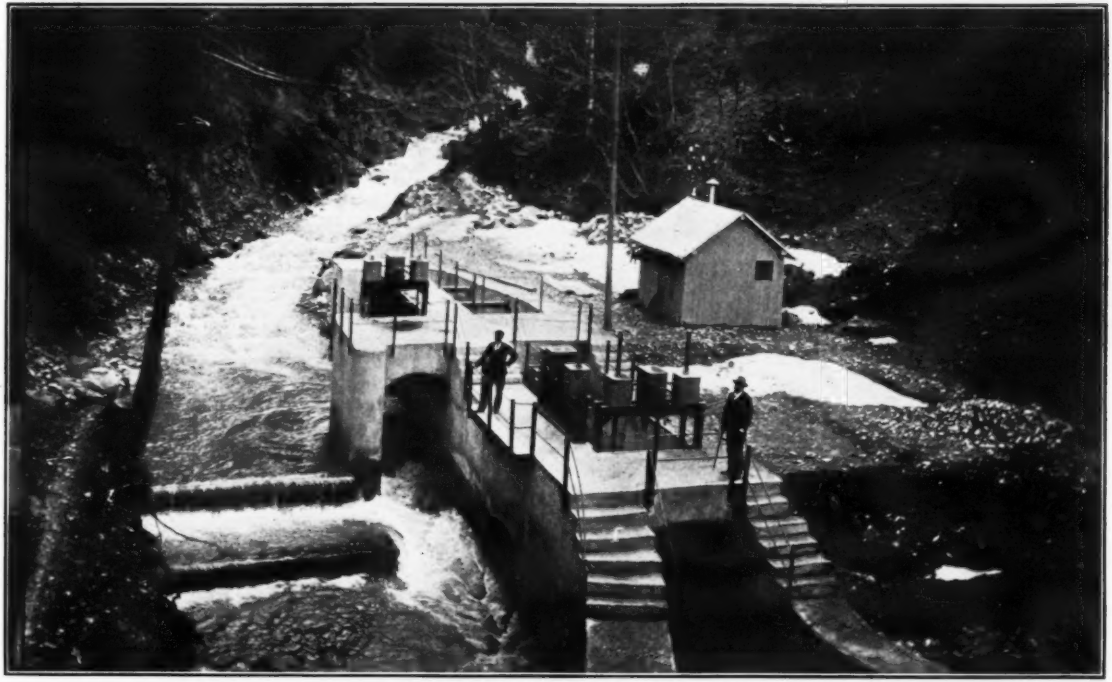
MAXIMUM WATER VELOCITY IN CHANNELS.

Material.	Velocity in feet per second.
Pure sand.....	1.1
Sandy soil, 15 per cent clay.....	1.2
Sandy loam, 40 per cent clay.....	1.8
Loamy soil, 65 per cent clay.....	3.0
Clay loam, 85 per cent clay.....	4.8
Agricultural clay, 95 per cent clay.....	6.2
Clay	7.35

The cross-section of a canal, be it trench or flume, should be such that the water will rise to about three-quarters or seven-eighths of the height, but it should never exceed seven-eighths, and should be so proportioned that the depth of the water is about half of the width.

For conveying the water through tunnels non-pressure or pressure tunnels are used, the former being the most common. A non-pressure tunnel is only partly filled, while a pressure tunnel of course is completely filled. The average slope for either is 1 to 2 feet in 1,000 and the tunnel must be of such size that the water velocity will be 7 to 8 feet per second. The cross-section of these tunnels may be rectangular with an arched roof, or semi-egg-shaped. Where they run through loose soil they must be lined with concrete or brick, the thickness of which depends, of course, upon the character of the soil.

In late years numerous installations of the pressure type of tunnels have been made. These must be properly lined and made water-tight as far as possible. Where these pressure tunnels are long, vent pipes



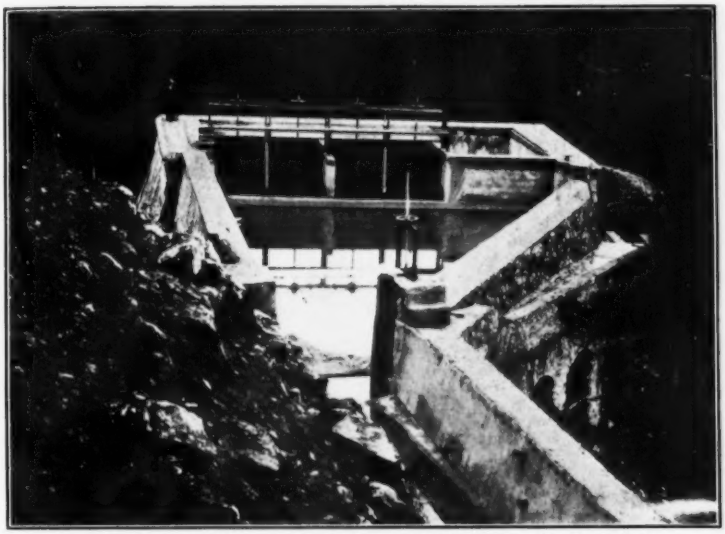
INTAKE TO HEAD-RACE OF A SMALL PLANT AT CHUR, SWITZERLAND.

must be provided so no air may enter the penstocks which, necessarily, must be connected to the tunnels without any intermediate collecting basin. A notable example, making use of a vertical shaft as an equalizing chamber, is found in the Urfttalsperre plant, Germany, which operates under a head varying from 230 to 360 feet. The shaft is located at the junction of the pressure tunnel (8,850 feet long) and the penstocks. It is sunk through the mountain and its upper end, which is above the high-water level of the reservoir, is enlarged to prevent overflow during sudden fluctuations, so that no water is wasted when the turbines are suddenly shut down.

DAM AND SLUICE GATES OF HEAD-RACE IN A SMALL TYROLESE PLANT.

The utilization of the water of mountain lakes may be accomplished either by tapping them at the bottom or by syphoning. The former method is very troublesome, as sheet piling must be driven and the water pumped out at the tunnel junction, and where soft soil is encountered it is particularly troublesome. In Switzerland, where many mountain lakes are found, the syphoning system has been introduced. This consists in sinking a vertical shaft a short distance from the shore of the lake; the water is syphoned from the lake to the shaft, to which latter the head race is connected. Such an installation will be found at Kubel and at Lake Poschiavo in connection with the Brusio power

HEAD-RACE OF THE PUENTALARRA PLANT, SPAIN.



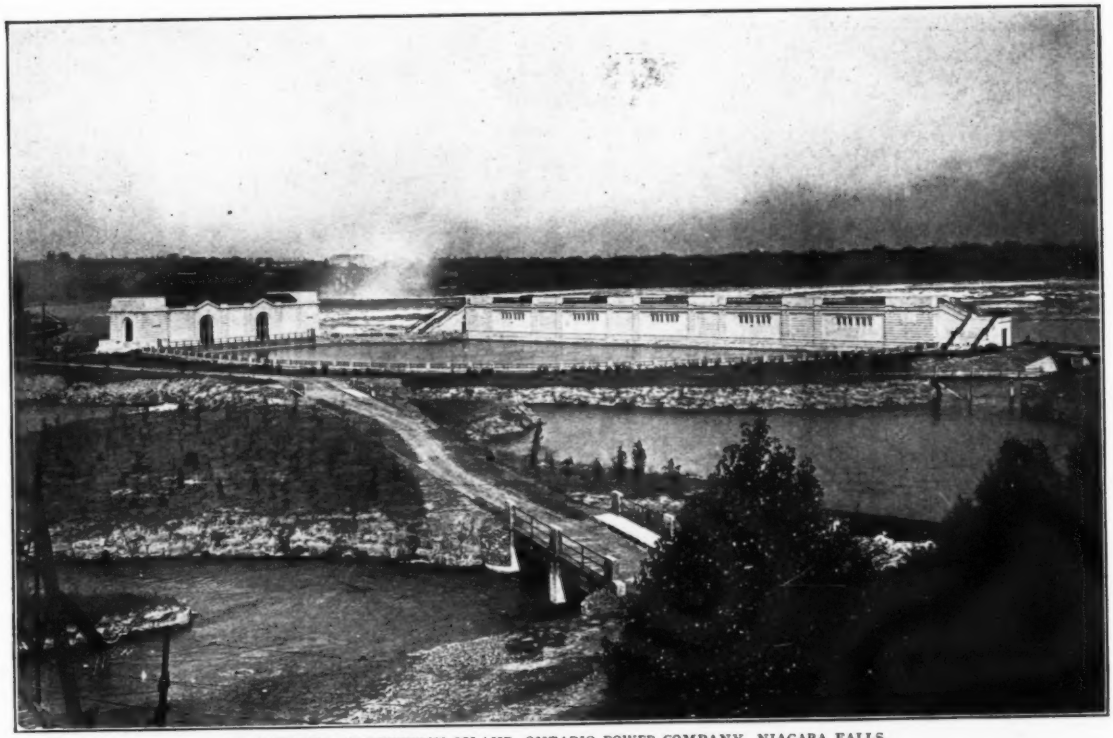
COLLECTING BASIN OF EL CORCHARDO HYDROELECTRIC PLANT, SPAIN.

plant. The shaft is sunk about 75 feet from the water's edge and carried 7.5 feet below the low-water level of the lake. The syphon tube leads from here into the lake and is 6.5 feet in diameter and 270 feet long, partly resting on trestle work. The suction leg is 26 feet long, provided with a screen and butterfly valve, while the discharge leg is 27.7 feet long, the bottom end of it being provided with a disc valve for regulating the flow of water.

The syphon is started by means of an air pump connected to the horizontal leg of the tube at its highest point, the slope of this leg being 5 feet in 1,000. It may also be started by the centrifugal pump which is installed for cleaning the intake screens.

The system must not be confused with the so-called "invert syphon" system, which is a misnomer, being nothing more than a pressure system. It must furthermore be remarked that this Swiss system is by no means a small affair as it syphons the supply of water for twelve 3,500-kilowatt turbines, installed in the largest hydroelectric plant on the Continent of Europe.

In other than pressure tunnels the junction between head race and penstocks must be made by introducing a collecting basin of sufficient size to allow for slight fluctuations of flow. The area of the head race may be increased at its junction with the collecting basin so that the



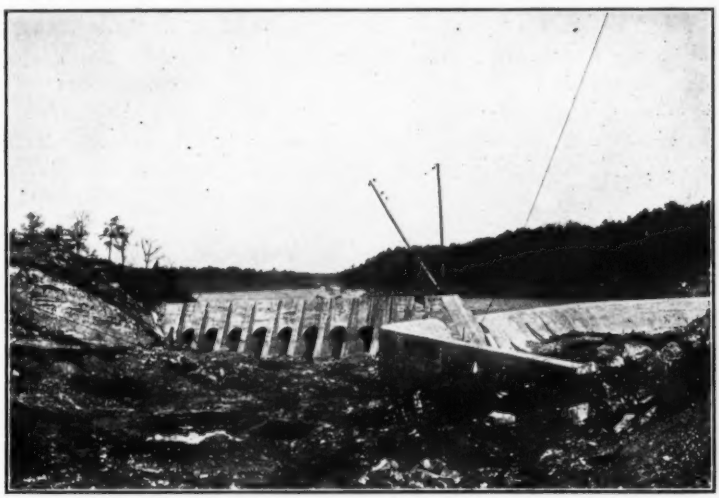
HEADWORKS AT DUFFERIN ISLAND, ONTARIO POWER COMPANY, NIAGARA FALLS.
Screen house and gate house at intake.

latter itself need not be too large. Under ordinary conditions the size of the collecting basin should be such as to reduce the velocity of the water to 1 foot per second, which will allow all heavy foreign material to settle, thus preventing it from entering the penstocks. It is, however, considered good practice to provide the penstocks with screens nevertheless. These screens are preferably set on a skew, so that the foreign matter may be forced to one side of the collecting basin where it may flow off through spillway sand or gravel traps.

All penstocks should be provided with cut-off valves at the collecting basin. They are usually of the gate type, butterfly valves being seldom used. The smaller sizes are hand-operated, the larger ones mechanical or motor-operated.

To protect the operating mechanism of the gates and screens a housing should be provided. In medium-head plants where the gates and screens are difficult to handle by hand, it is advisable to install a hand-operated travelling crane.

Screens are generally made of 2-inch by ⅜-inch bars, spaced ⅝ inch to 1 inch apart. They are preferably made in sections, unless very small, so that they may be easy to operate. In many instances duplicate sets are used, the mechanism being such that when one section is raised for cleaning, the other is lowered into position. Where heavy floating material or anchor ice is encountered racks should be



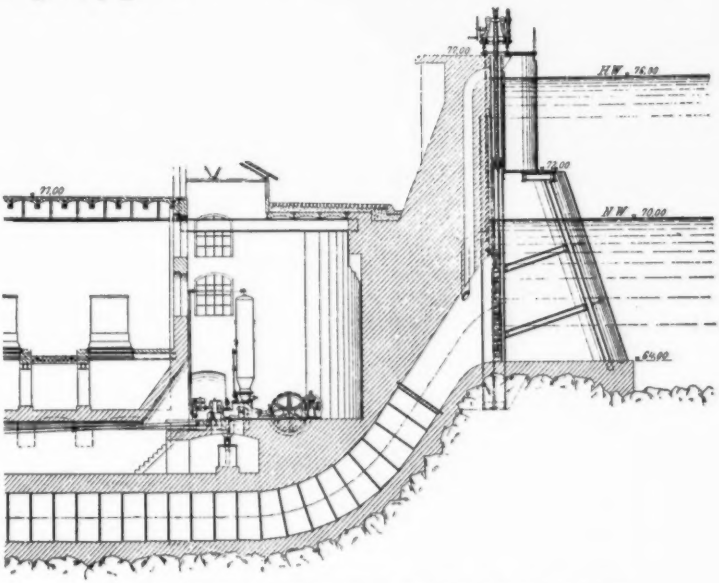
SPILLWAY HEADGATES AND CANAL OVERFLOW, GREAT FALLS PLANT.

SCREEN HOUSE, PLANT NO. 2, NIAGARA FALLS POWER COMPANY

installed either at the inlet to the head race or at forebay in low-head plants. Racks are frequently made of round bars or tubes; this, however, is not good practice, as foreign material will gather more easily on round bars than on flat ones. Furthermore, it is more troublesome to clean racks made up of round bars for the reason that the wedge-action of the floating material is greater with these than with flat bars. The spaces between bars should not be less than ½ inch and should never exceed 4 inches. When the racks must withstand heavy shocks from floating or anchor ice, or logs, etc., the bars should preferably be made of I beams. Such construction is seen in the screen installations illustrated on pages 185 and 187. It acts simultaneously as a deflector for throwing all floating material over the spillway. It will be noticed that the rack, as it is of heavy construction and built in sections, is raised, in sections, by means of a windlass travelling on a bridge from which the sections are supported. By means of these racks the head of water may also be regulated as the area may be reduced or enlarged according to the position given to the rack. Directly behind this rough rack and deflector is a sand trap and a fine screen, so that the collecting basin is well protected.

For controlling the water-supply to the head race vertical moving sluice gates are provided which, up to 100 square feet in size, are made of wood, while those of larger size are of structural steel. If conditions favor the use of large wooden sluice gates these must be made in sections, as the gates would otherwise be too bulky. The large gates

should be provided with rollers, while the smaller wooden sluice gates may run on iron or brass strips, the latter being preferable. When there are a great number of gates of large size they are preferably operated by motors, and one portable motor may be used. Provision, however, should be made also for operating them by hand, and to facilitate this counterweights should be applied. Where quick action is desirable, air or hydraulic pressure cylinders may be used for operating heavy gates.

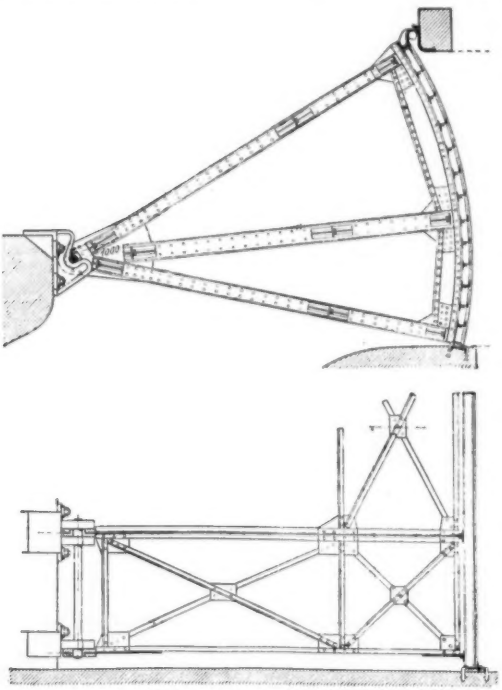


SCREENS, GATE AND PENSTOCK, KYKKELSUND PLANT, NORWAY.

Drum gates are also used in connection with low-head plants, the construction forming a segment of a drum as seen on page 186. Such gates have been installed in connection with the Chèvres plant in France, being located in the turbine chambers, and as the pressure is against the drum, with a tendency to push it away from the seat, care must be taken to prevent excessive leakage. This may be accomplished by a rope or steel cable at the top edge as shown, and by wooden blocks at the bottom, upon which the gate rests.

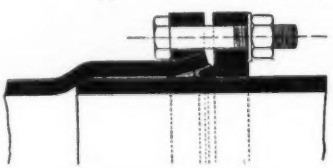
Gates of similar design are frequently found in the western States for increasing the head at a dam, acting as a flash-board or movable dam.

PENSTOCKS.—Penstocks are made either of steel-plates, riveted or welded, of wooden staves, or of reinforced concrete. The riveted steel plates are much used. However, for exceptionally high heads, and to reduce the friction due to the large number of rivets necessary, welded-tube sections, made so as to telescope, have been much used in Europe and also, of late, in America; the penstocks installed for the Western Power Company and for the Necaxa plant in Mexico being partly of this type. For the last named plant there are six 30-inch penstocks, each having a length of 2,460 feet. The lower sections are subjected to a static head of 1,200 to 1,300 feet and the thickness of the shell varies from 0.4 inch to 0.95 inch. They were shipped from Germany in sections 29.5 feet in length. As the penstocks in high-head plants are of larger diameter for the upper than for the lower sections, and as all sections are provided with loose flanges, they may be nested for shipping, thus securing another great advantage.



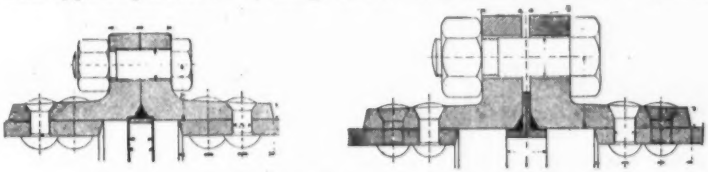
DRUM GATE AS INSTALLED AT THE CHEVRES PLANT, FRANCE.

The flanges of this type of penstock are as shown on this page. It will be seen that one end of the tube is enlarged to receive the straight end of the next section, thus doing away with the otherwise necessary expansion joints, as a slip



FERRUM SLIP-JOINT FLANGE.

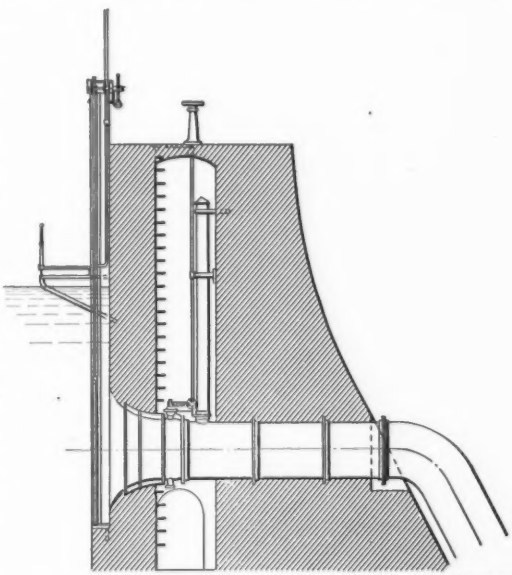
joint is provided. One of the flanges is provided with a beveled lip which fits into a corresponding recess of the large end of the pipe and forces therein a tapered soft-metal ring, thus making a tight joint. This type of penstock and flange is also used in the Loch Leven plant,



TYPES OF PENSTOCK FLANGES USED IN RECENT LEWIS PRACTICE.

Scotland, where six are installed, each having a length of 6,230 feet. The lower sections are subjected to a pressure of 425 pounds per square inch. They are 40 inches in diameter and the thickness of shell varies from ⅜ to ⅞ inch. These penstocks are laid in sections 19.7 feet in length and held in place by concrete anchor blocks about 175 feet apart.

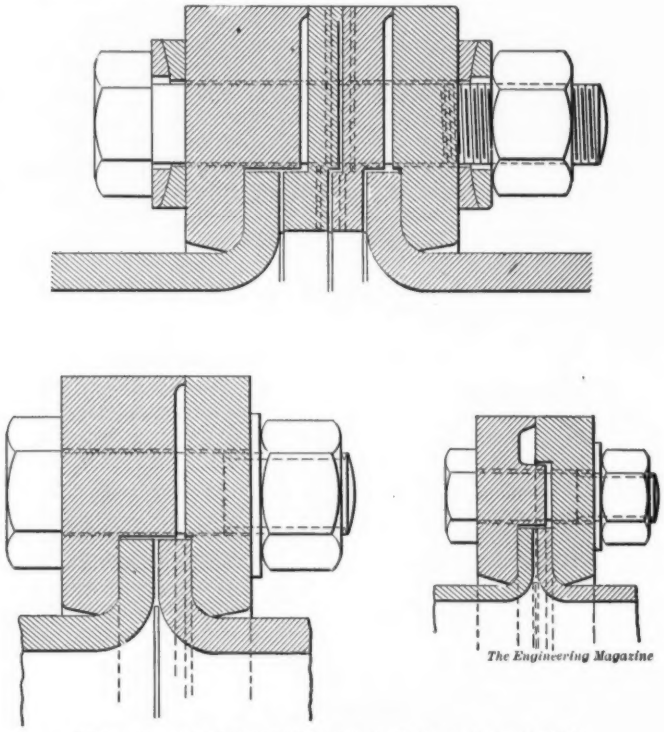
On page 188 are shown three different designs of flanges as used in the Necaxa penstocks. It will be noticed that the flanges have a lever action on the flared ends of the penstocks. Where ordinary riveted steel penstocks are used, and so long as they are not laid underground, expansion joints must be provided; these are preferably of the stuffing-box type. Where slip-joints are provided at intervals the anchors of the pipe must be arranged accordingly, so that the expansion between two ancher-blocks is properly taken up. The



The Engineering Magazine

TYPICAL ARRANGEMENT OF DOUBLE SCREENS AND VENT FOR PENSTOCK INLET.

penstocks should rest on saddles, and to allow for creeping these should be of cast-iron mounted on masonry blocks.

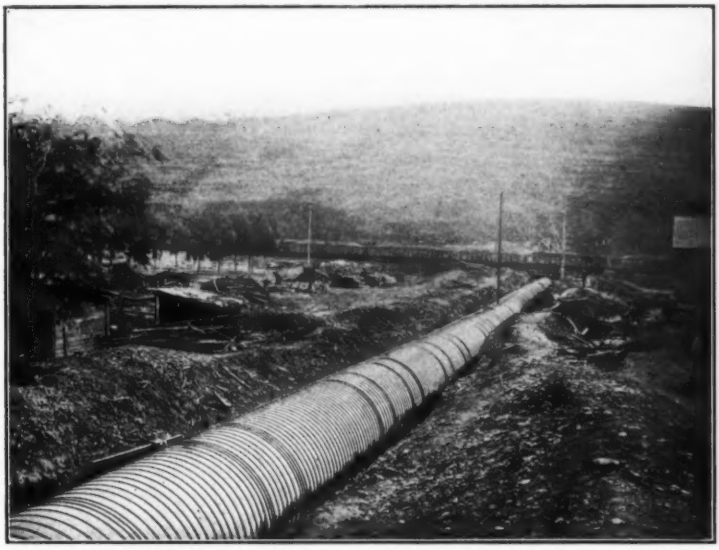


TYPES OF PENSTOCK FLANGES FOR NECAXA PLANT, MEXICO.

Wooden penstocks are practically installed for heads not exceeding 300 feet, and for higher heads the lower sections should be made of steel. Some of the advantages of these over metal or concrete penstocks are their smoothness, giving a greater carrying capacity, ranging from 10 to 20 per cent over the others. They are, furthermore, cheaper in first cost and do not deteriorate as rapidly as those of metal, nor does frost affect them. In some cases it might be extremely difficult to transport heavy steel penstocks over a country where there are no roads. The staves and bands for wooden penstocks may be easily transported by mules through woods or mountainous country.

PENSTOCK BRIDGE, CHUR PLANT, SWITZERLAND.

A good example of wooden-stave penstock installation is that in connection with the Bishop Creek power plant. One pipe is 42 inches



EIGHT-FOOT WOODEN-STAVE PENSTOCK, PENDLETON ROLLER MILL CO., PENDLETON, OREGON.

in diameter and 6,700 feet long and another is 30 inches in diameter and 2,150 feet long. The 42-inch penstock is made up of 25 staves and the 30-inch of 19 staves, milled from 2 by 6 inch stock, which is red fir from southern Oregon. The bands are made of mild steel ½ inch in diameter, with ends upset to ⅝ inch in diameter. They were shipped straight and bent to form on the spot. The lugs are of cast-iron, of a form to allow the ends of the bands to pass each other, nuts being used on both ends. The spacing of the bands is 6 inches for the 42-inch pipe. The ends of the staves are slotted and a 3/16 by 1/2 inch compressed paper dowel is inserted. When wet these dowels swell and prove very efficient for closing up leaks.

Large radius bends are readily made, but cast-iron or rivetted steel bends are inserted for bends of small radius. Where small pipes are branched from the side of the main penstock cast-iron saddles are provided and fastened by bands similar to those described.

Reinforced-concrete penstocks have not been used to a great extent, though for low-heads they have been in use in France for a number of years. They are made by the use of inner and outer forms, the concrete being used rather wet and tamped. Rods are usually used for reinforcement, although expanded metal or similar material may be used.

A new process, the Siegwart system, has been developed in Switzerland whereby penstocks of reinforced concrete can be made by machinery, capable of carrying pressures up to 300 pounds per square inch and higher. Being manufactured by automatic machinery of very compact design these penstocks can be rapidly made in the field, in sections the length of which depends upon the size of the machine used. The ends are fitted with special joints which, after the penstock is in place, are filled with asphalt. An external band is slipped over the joint and sealed by the asphalt. After coming from the machine the sections are coated inside with a layer of asphalt. This treatment renders the penstock absolutely water-tight and in addition reduces skin friction.

The present practice is to install a number of penstocks rather than one large one. They should be arranged side by side and the bed selected for them should be made as even as possible. If the natural soil is unsafe to carry the penstocks it must be reinforced to avoid any possibility of land slides, which in some cases have put penstocks out of commission. When a number of penstocks are installed it is well to build, as a part of the penstock bed, a permanent road by which means sections of the penstocks are also conveyed to

A 7-FOOT WOODEN-STAVE PENSTOCK, 3700 FEET LONG, UTICA GAS & ELECTRIC COMPANY, TRENTON FALLS, N. Y.

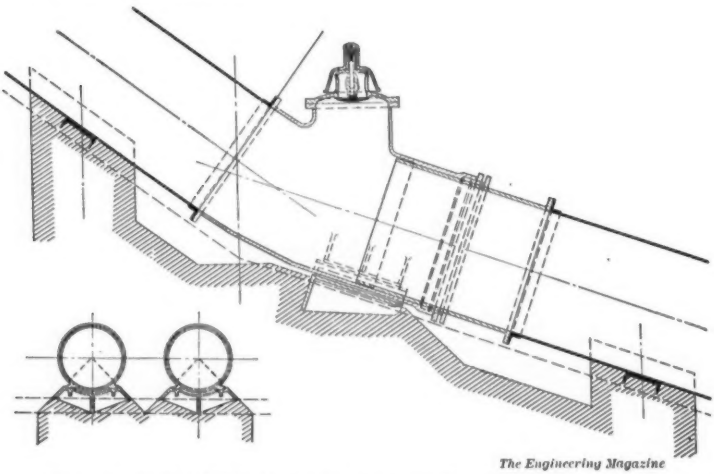
their place. Such practice is frequently adhered to in Switzerland and Italy, the plant at Brusio being a good example. Here a motor-operated cable road is installed on the mountain slope beside the penstocks. Now that the penstocks are in place this is used for inspection and repair purposes.

Where multiple penstocks are laid they must be inter-connected, preferably near the power house, and properly equipped with valves so that, in case of emergency, the water of any penstock may supply any other turbine.

The penstock run must be the most direct that can be had and planned so as to avoid short turns, to minimize the friction. To shorten the run they may be carried through tunnels or across valleys on trestles or piers.

The size of the penstock depends, of course, upon the amount of water to be supplied and the head available; conditions being equal, the velocity of the water under high head must be greater than that under low head. However, plants have been installed in contradiction

to this theory; for instance, the horizontal section of the 18-foot penstock of the Ontario Power Company's plant, under a head of 20 feet, has a velocity of 15 feet per second, while the velocity in a 30-inch penstock of the Necaxa plant, under a head of 1,300 feet, is 15 feet per second under a normal full load, while under an extremely high load it is 18 feet per second.



VACUUM RELIEF VALVE PLACED NEAR LONG VERTICAL SECTION OF PENSTOCK, VAUDOISE PLANT AT LAKE ORBE.

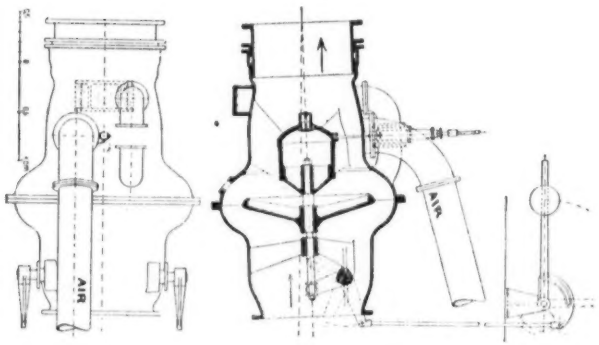
As an average it may be said that penstocks from 1 to 2 feet in diameter have a velocity of from 20 to 30 feet per second, while under a head of 1,000 feet or more and for penstocks of 2 to 3 feet in diameter the velocity chosen should be 10 to 16 feet per second.

The losses due to friction depend upon the head and the diameter of the penstocks, as well as upon the condition of the inside surface of the pipe, whether rusty, full of silt, dents in the pipe, etc. In brief, the law may be stated as follows: 1, for equal velocities the friction loss is proportional to the length of the penstock; 2, friction increases very nearly as the square of the velocity; 3, for equal lengths of penstocks, the friction decreases with the increase in diameter; 4, the rougher the interior surface the greater the friction. The accompanying table is an abstract from table of the Pelton Water Wheel Company. It gives the loss of head by friction for each 100 feet of penstock at different diameter, under different discharges, in cubic feet at velocities of from 2 to 7 feet per second.

LOSS OF HEAD BY FRICTION IN PENSTOCKS.
Inside diameter of pipe in inches.

Vel. in feet per sec.	12 Loss of head in feet.	12 Cubic feet per min.	13 Loss of head in feet.	13 Cubic feet per min.	14 Loss of head in feet.	14 Cubic feet per min.	15 Loss of head in feet.	15 Cubic feet per min.	16 Loss of head in feet.	16 Cubic feet per min.	18 Loss of head in feet.	18 Cubic feet per min.
2.0	.198	94	.183	110	.169	128	.158	147	.147	167	.132	212
3.0	.407	141	.375	166	.349	192	.325	221	.306	251	.271	318
4.0	.685	188	.632	221	.587	256	.548	294	.513	335	.456	424
5.0	1.03	235	.949	276	.881	321	.822	368	.770	419	.685	530
6.0	1.43	283	1.325	332	1.229	385	1.148	442	1.076	502	.957	636
7.0	1.91	330	1.75	387	1.630	449	1.520	515	1.430	586	1.270	742
	20		**22**		**24**		**26**		**28**		**30**	
2.0	.119	262	.108	316	.098	377	.091	442	.084	513	.079	589
3.0	.234	393	.222	475	.204	565	.188	663	.174	770	.163	883
4.0	.410	523	.373	633	.342	754	.315	885	.293	1026	.273	1178
5.0	.617	654	.561	792	.513	942	.474	1106	.440	1283	.411	1472
6.0	.861	785	.782	950	.717	1131	.662	1327	.615	1539	.574	1767
7.0	1.143	916	1.040	1109	.953	1319	.879	1548	.817	1796	.762	2061
	33		**36**		**39**		**42**		**45**		**48**	
2.0	.073	712	.066	848	.061	995	.057	1155	.053	1325	.050	1508
3.0	.148	1070	.135	1273	.125	1442	.117	1730	.109	1987	.102	2260
4.0	.248	1425	.228	1697	.210	1990	.195	2310	.182	2650	.171	3016
5.0	.374	1780	.342	2121	.316	2490	.294	2885	.273	3310	.256	3770
6.0	.520	2140	.479	2545	.441	2986	.408	3461	.382	3970	.358	4524
7.0	.693	2495	.636	2968	.586	3484	.545	4030	.509	4638	.476	5277

For protecting the penstocks against surges, vacuum, frost, etc., they must be provided with relief devices. The upper end of the penstock should be fitted with a vent pipe which must extend above the high-water level of the collecting basin or reservoir. This vent pipe under all circumstances must be protected against freezing up; otherwise it may fail of its object. Where, after a long horizontal run, a drop of any great extent occurs, a vacuum relief valve must be inserted near the upper end of the drop leg, for the purpose of letting in air to prevent the creation of a vacuum which might form when the turbine gate is open, because the velocity in the vertical section is greater than in the long horizontal line. The lower ends of the penstock must be provided with relief valves or blow-out plates, or standpipes, so that in case of a sudden shut-down of the turbines surges in the penstock are eliminated. Standpipes are usually connected at the end of the penstocks and must extend vertically several feet above the water level in the collecting basin. Standpipes are usually wasteful, as they may overflow in the event of a sudden increase of pressure. Another method is the provision, at the lower end of the penstock, of an air-cushion which is nothing more than an enclosed chamber; this



AUTOMATIC LOW-WATER DEVICE FOR PROTECTING PENSTOCK.

must be kept absolutely air-tight or the device will be rendered useless. In connection with the Jajce plant in Bosnia, in 1899, I experienced this difficulty, and to remedy it an air pump had to be installed to maintain the air-cushion.

In exceptionally cold regions penstocks must be protected against freezing. They may be imbedded in the ground below the frost line, or protected by wooden boxes. In the former case the trench must be left open at least several months after operation has commenced to ascertain whether additional caulking is necessary. All steel penstocks must be coated with asphalt, both inside and out.

THE FUEL-BRIQUETTING INDUSTRY.

By Charles L. Wright.

FUEL DRIERS AND BRIQUETTING MACHINES.

Published with the Approval of the Director of the U. S. Geological Survey.

Mr. Wright is Assistant Engineer, U. S. Geological Survey, in charge of the fuel-briquetting section. He had charge of the chemical and physical tests of briquets and binders at the St. Louis Fuel-Testing Station, superintended the installation of the Government briquetting plant at Norfolk, and later succeeded to charge of the briquetting investigations and installed the briquet plant at Pittsburg, Pa. His articles are prepared under the auspices of the U. S. Geological Survey, as a concise and comprehensive review of the "State of the Art." The first section took up plant, materials and processes; the second part is descriptive and illustrative of equipment and machinery for briquetting, concluding with a discussion of the properties of briquetted fuel, and some statistics of production.—THE EDITORS.

SOME fuels, but more especially lignites and peat, require drying before briquetting. Lignites fresh from the mines in Germany contain as high as 60 per cent of moisture, and sample of American lignites investigated by the U. S. Geological Survey have contained as high as 42 per cent of moisture. Before briquetting this fuel it must be dried considerably so as to contain from 5 to 15 per cent moisture in the briquets. If dried too much it will not briquet. Therefore, to make briquets successfully from lignites requires close control of the drying, and the amount of moisture is the most important factor in briquetting this fuel.

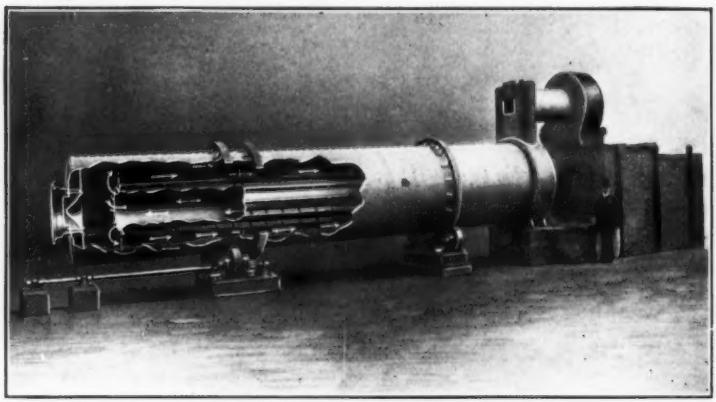
In Germany there are two general types of driers in use in briquetting plants.

One of them, the plate type, consists of a series of circular steam-heated plates arranged one above the other, over which plates the material is moved by scrapers from the center toward the outer edges of one plate, then drops through holes onto the plate below, is scraped from the outer rim toward the center of this plate, then drops through holes onto the next lower plate, and so on through the drier.

On account of the large number of moving parts in the plate drier and their liability to get out of order, this type of drier is gradually being superseded by another type of drier, known as the Schulz drier. This Schulz drier resembles a multitubular boiler sup-

ported on bearings at each end, in an inclined position, so that by revolving the drum, the material will move through the tubes by gravity. These driers are 21 to 26 feet long and 7 to 11½ feet in diameter, and have 240 to 364 drying tubes 3¾ inches in diameter, so they have 4,640 to 8,180 square feet of heating surface and will dry in 24 hours from 45 to over 70 tons of wet lignite.

Other types of driers are more commonly used for drying materials in the United States, such as the long, hollow cylindrical driers placed in an inclined position, and heated by direct heat while revolving, the gas passing through the cylinder in some cases.



THE RUGGLES-COLES ROTARY DRIER.
Ruggles-Coles Engineering Co., N. Y.

For drying and heating bituminous or anthracite coal for briquetting, another type of drier known as the Bietrix furnace is used in France. It consists of a circular brick chamber in which is revolved a circular horizontal table. Direct heat is passed over this table from a firebox at the side. Scrapers move the coal, while drying, from the center to the outer edge of the table, where it is discharged through openings in the casing. This type of drier is said to be continuous and highly efficient in action.

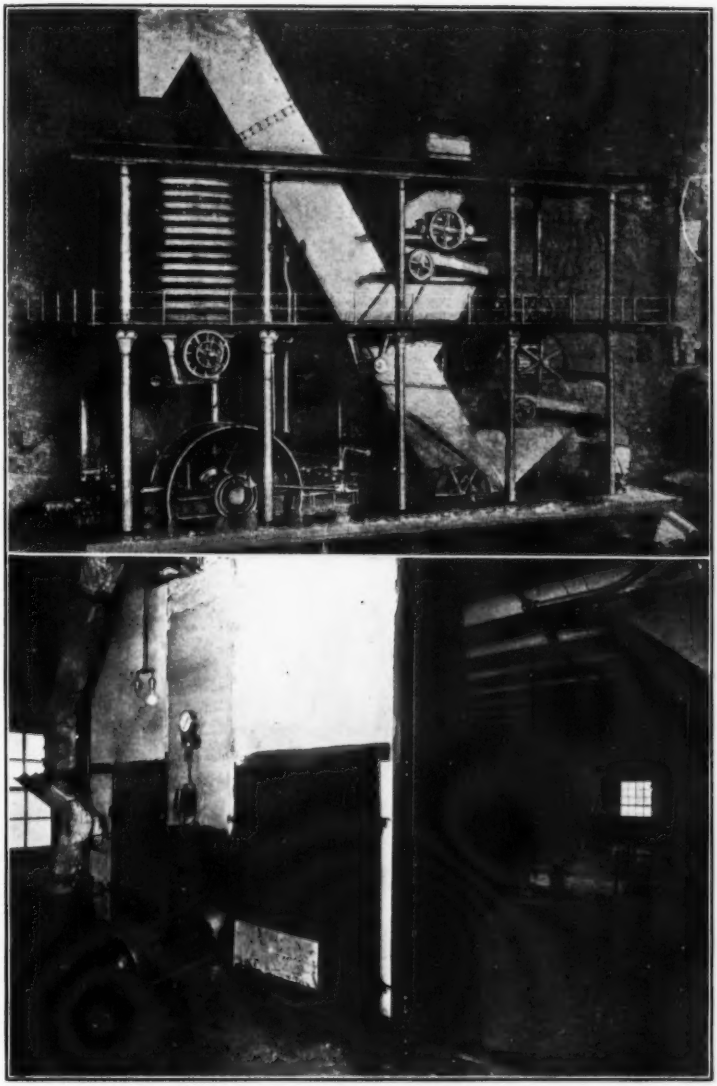
Classes and Characteristics of Presses Used for Fuel Briquetting.

The presses used for briquetting fuel are of three general classes:

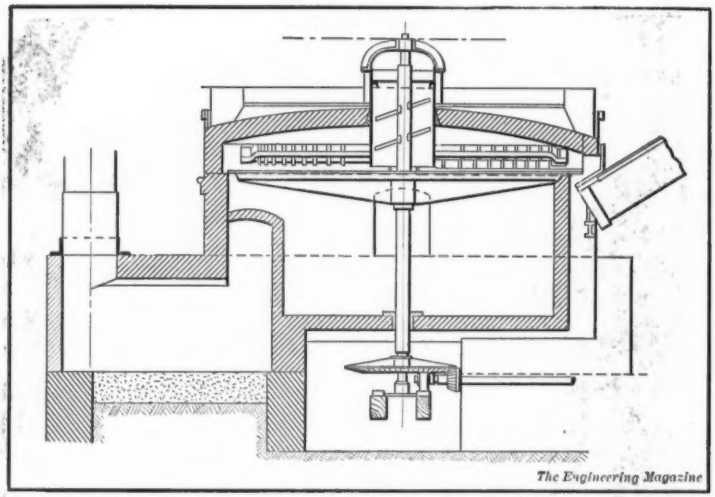
Class I. Open-mold machines.

Class II. Closed-mold machines.

Class III. Tangential or rotary machines.



ABOVE, MODEL OF A GERMAN LIGNITE BRIQUETTING PLANT EQUIPPED WITH A PLATE DRIER. BELOW, SCHULZ REVOLVING TUBULAR DRIER.



BIETRIX DRYING AND HEATING FURNACE.

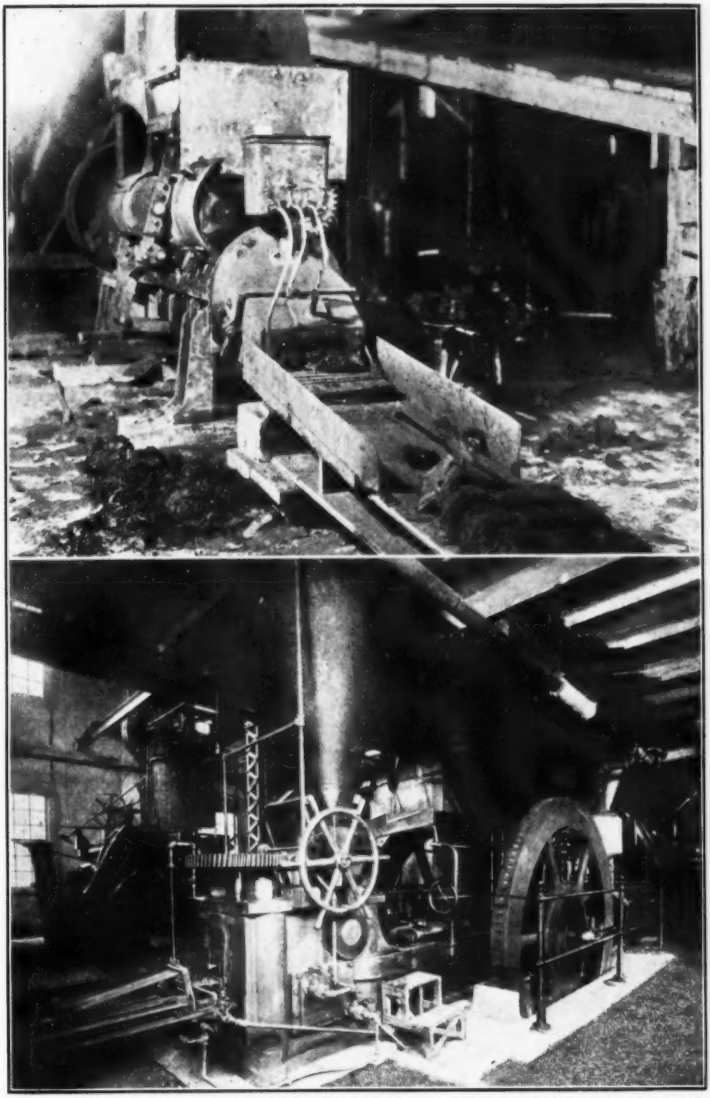
The space allotted to this paper allows of only a brief discussion of the various types of presses.

Class I. Presses of the open-mold class, as the name suggests, are provided with molds open at one end, and the pressure is obtained by the resistance offered to the material in passing through a gradually narrowing opening. Presses of this class are in use in brick and tile industries and the augur brick machine may be mentioned as typical. For fuel briquetting, open-mold machines are used commercially only for briquetting lignites and peats, although a press with open molds has been used to some extent in Belgium for briquetting washed scale containing as high as 20 per cent of water.

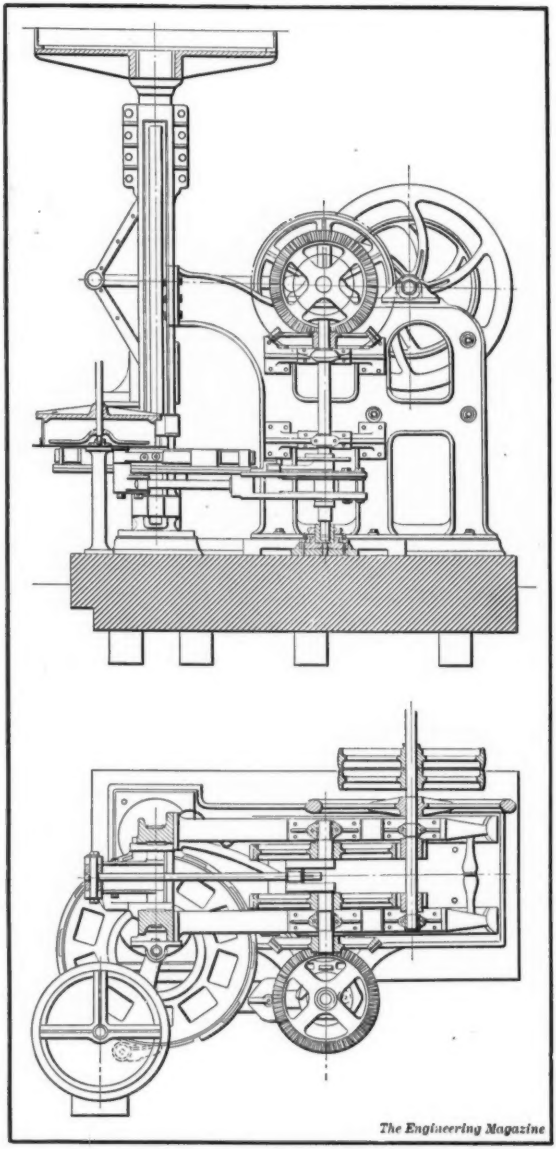
The following fuel briquet presses belong to this type:

1. The Exter press.
2. Bourriez press.
3. A press known in England as Johnson's briquet press, which however must not be confused with the Johnson press belonging to the Survey, which is of an entirely different type.
4. Max Everard's briquet press.
5. The Schlickeysen peat machine, which is typical of other peat machines.

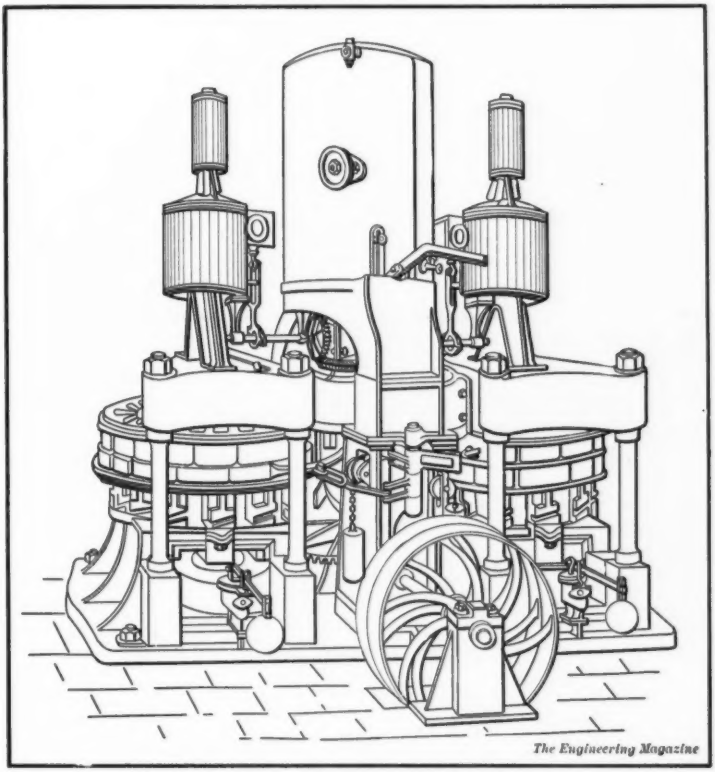
The Exter and Schlickeysen presses are shown in the illustration on the opposite page.



ABOVE, SCHLICKEYSEN WET-PEAT BRIQUETTING MACHINE. BELOW, EXTER LIGNITE AND PEAT BRIQUETTING PRESS.



THOMAS MIDDLETON BRIQUET MACHINE.



MAZELINE BRIQUET PRESS. A SINGLE-COMPRESSOR TYPE.

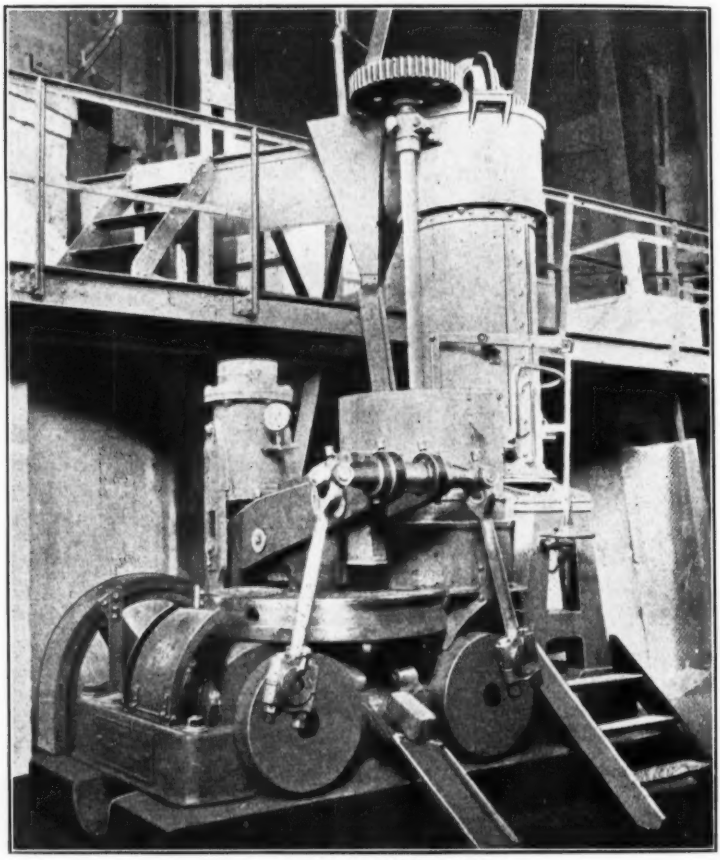
Class II. Briquet presses having closed mold may be divided into two types:

a. Single-compression machines.

b. Double-compression machines.

a. In the single-compression machine the material in the mold is compressed by a plunger from one side of the mold only, while in the double-compression machines both sides of the briquet are simultaneously compressed by double plungers, and the resultant briquets are more homogeneous than those made by the single-compression machines.

As types of the single-compression machines the following may be mentioned: Thomas Middleton's press, patented in England in

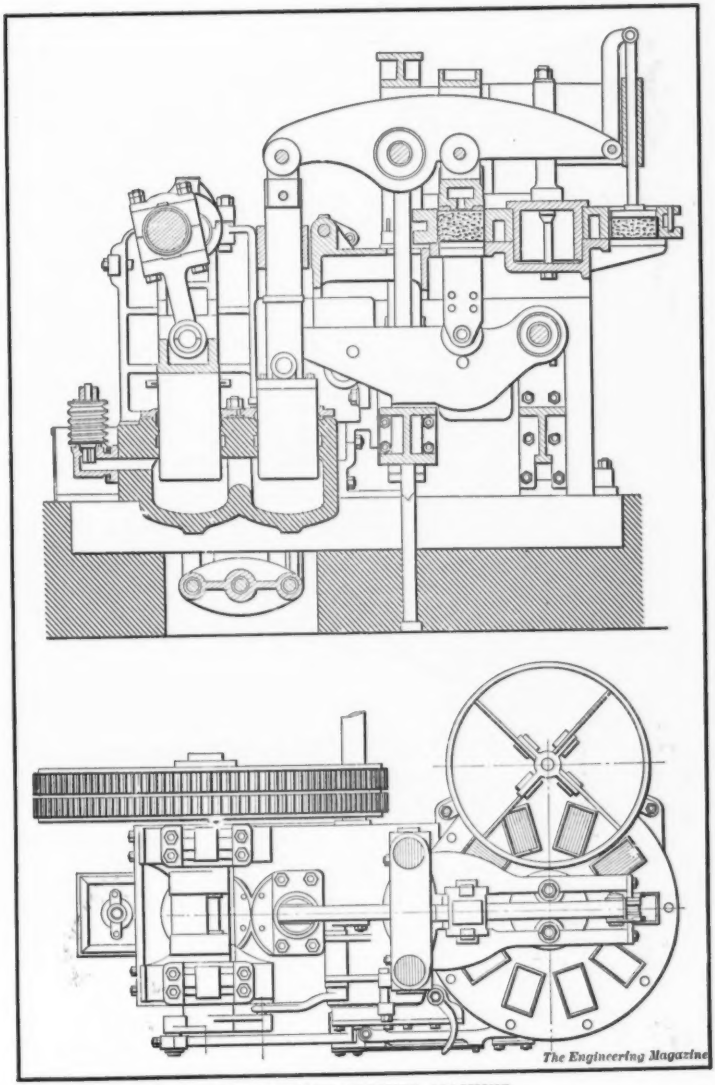


THE COFFINHAL BRIQUET PRESS.

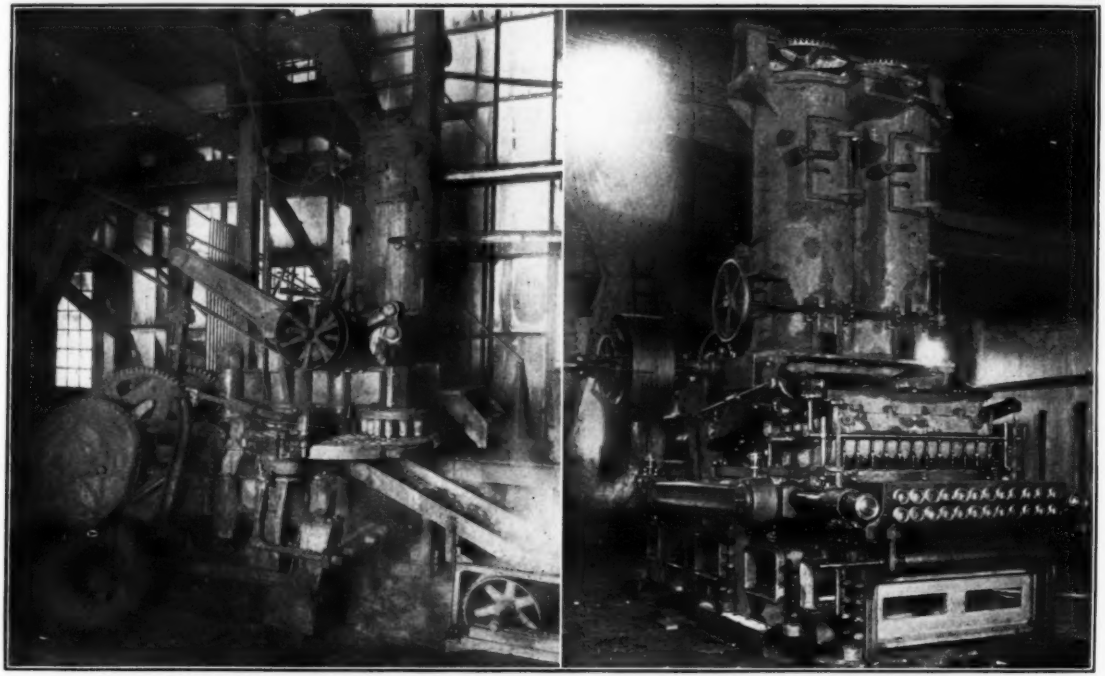
1844; Mazeline press; Stevens press, manufactured by the Uskside Engineering Company.

b. The following machines are of the double-compression type of press:

Coffinhal Bietrix machine.
Yeadons double-compression press.
Roux-Veillon press.
Johnson briquet machine.



ROUX-VEILLON BRIQUET MACHINE.



MISNER BRIQUET MACHINE.

RENFROW BRIQUET MACHINE.

The Misner high-pressure machine was built for the Standard Briquet Fuel Co. and photographed in operation in their plant. The Renfrow machine is installed at St. Louis.

JOHNSON (ENGLISH) BRIQUETING MACHINE.

The following American presses are also of this type:

Renfrow briquet machine.

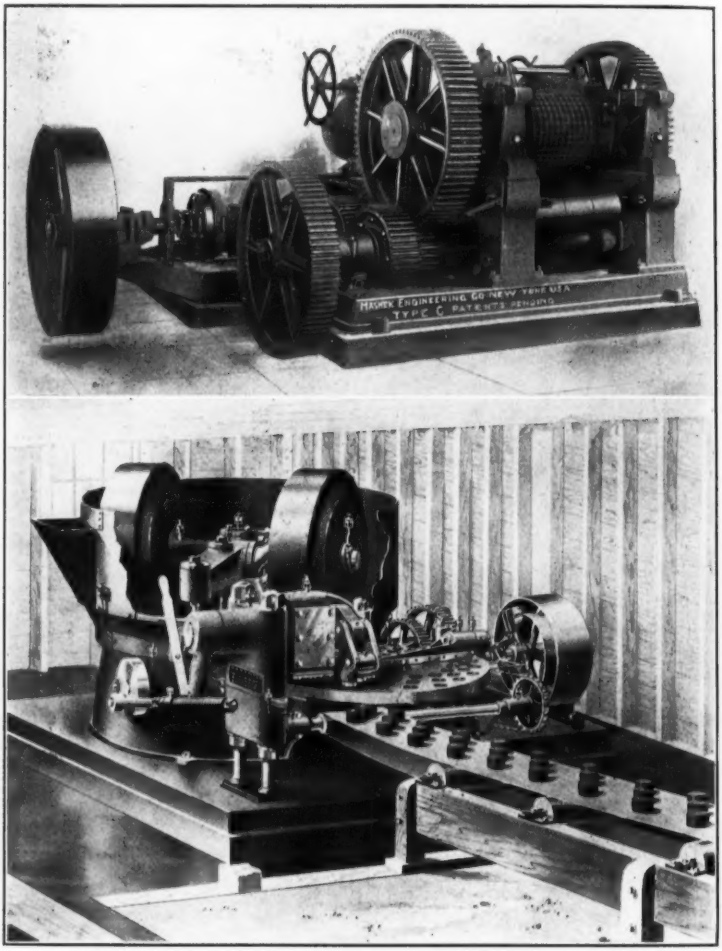
Misner press.

Class III. Tangential or rotary briquet presses. This class may be divided into two types:

a. Roll type of presses.

b. Rotary-plunger machines.

a. Roll type of press. This type of press consists of two rolls of the same diameter which are geared together so that one turns with the other at the same surface speed. In the face of these rolls pockets

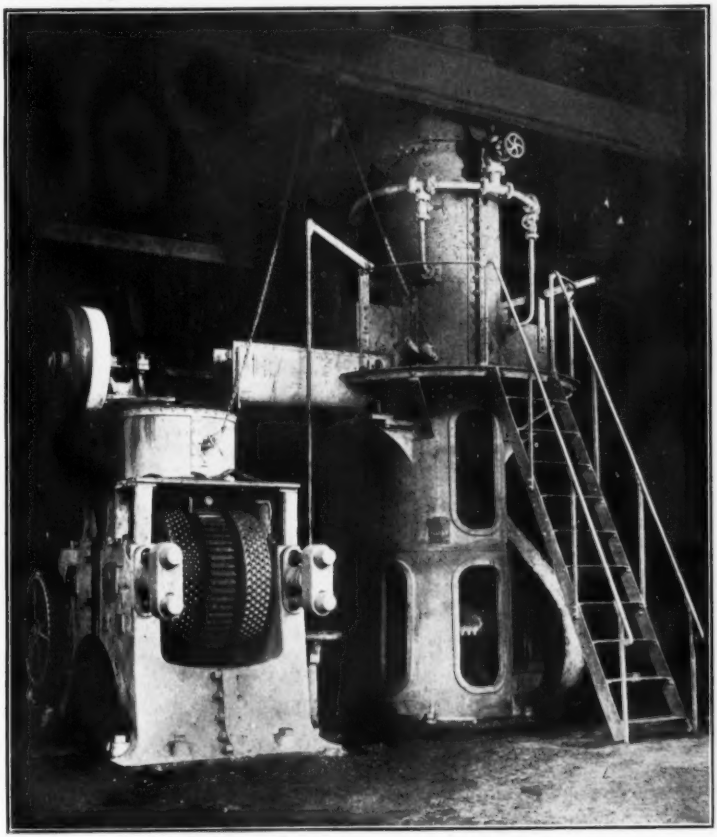


ROTARY BRIQUET PRESSES.

Above, briquet press by the Mashek Engineering Company, N. Y. Below, press of the Chisholm, Boyd & White Company, Chicago, Ill.

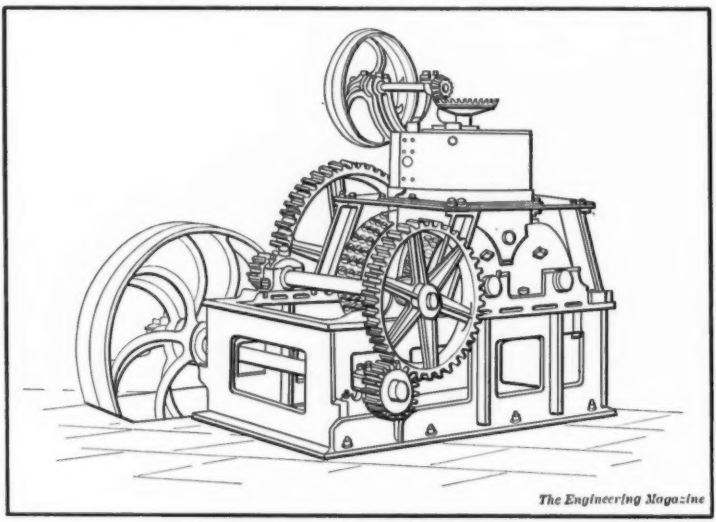
are arranged so that the pockets on each roll register perfectly with the corresponding pockets on the other roll. The prepared material is fed to these rolls from a hopper over them, and the turning of the rolls briquets the material. These presses have large capacity and are

simple to handle, but they are not suited to make briquets weighing more than five or six ounces, and they require more binder than plunger machines to produce briquets of equal strength. They are especially adapted for making small-sized briquets and have been used in the United States in at least two of the successful briquetting plants. These machines have the advantage over plunger machines of being continuous in action so that there is no lost motion. They make briquets of various shapes, the pillow shape being the most satisfactory.



DEVILLERS BRIQUET MACHINE. ROTARY TYPE.
Robert Devillers, Brooklyn, N. Y.

The following presses are of this rotary or tangential type.
Mashek press. (see page 206.)
Mulheim and Zimmermann's press.
Fourquensberg's press.
Hall-Bjorling patent fuel machine.
Loiseau press.
Devillers press. (See page 207.)
Chisholm, Boyd & White press. (See page 206.)

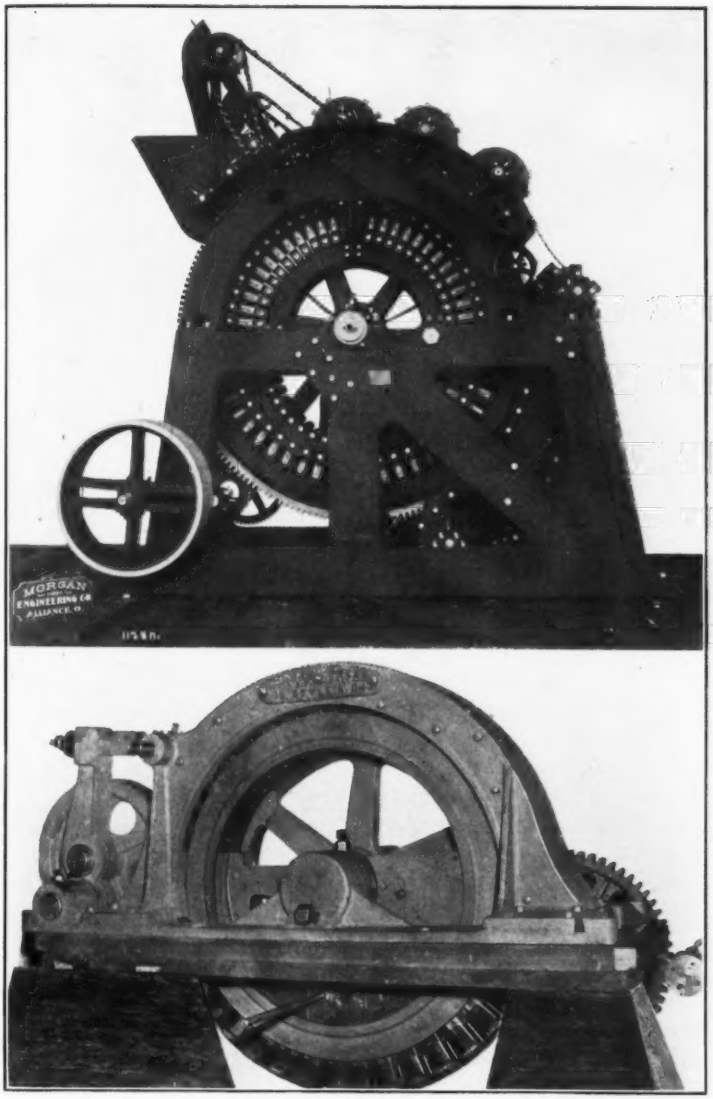


ZIMMERMANN BRIQUET MACHINE.

b. The rotary-plunger type. The distinguishing characteristic of this style of press consists in a series of plungers radially located in the rim of a wheel, some machines having only one ring and others having several rings of molds in the rim of the wheel. This type of press has the valuable features of continuous action, no lost motion, and high capacity of the roll press, and the added advantage of being able to make briquets with less binder and greater coherence than the roll machine while the size of the briquet that can be made on this machine is greater than that possible with the roll type. The following machines are of the rotary-plunger type:

Brogueaux press (France).

Ladley press, made by the National Pressed Fuel Co. of Indianapolis.



BRIQUET PRESSES OF ROTARY PLUNGER TYPE.

Above, Ladley's rotary plunger machine, built by the Morgan Engineering Company and illustrated by courtesy of the Indianapolis Pressed Fuel Company. Below, the Schorr press, made by Robert Schorr, San Francisco, Cal., and shown by courtesy of J. Bordollo, Kingsbridge, N. Y.

Schorr press, designed by Mr. Robert Schorr, a consulting engineer of San Francisco. (See page 209.)

Advantages of Briquetted Fuel.

Briquets, when properly made with a suitable binder, possess the following advantages over raw fuel:

1.—The even size of the briquets permits of a more regular and thorough combustion in the firebox or furnace, as the spaces that exist between adjacent blocks allow of even distribution of air through the fire and the pressure drop through the fire is also less.

2.—A good briquet holds its shape in the fire, so that even when coking coals are used they do not coke together sufficiently to cut off the air for combustion and the gases are burned as fast as distilled off, so that

3. Practically no smoke should be obtained from the combustion of good briquets.

4. Briquets generally burn to a fine ash rather than a clinker, as in the briquetting process the mixing and grinding thoroughly distribute the ash material, which in the raw fuel exists in spots and layers and is fused into clinker instead of falling through the grate.

5. The characteristic fineness of the ash from briquets allows of keeping a better fire with less attention and poking than is possible with raw fuel under the same conditions.

6. The evaporation per pound of fuel is greater for the briquetted than for the same coal in its natural state. This advantage is maintained at all rates of evaporation.*a*

7. The capacity of a boiler is considerably increased by the use of briquetted fuel.*a*

8. The weather-resisting qualities of many coals, and especially lignites, are greatly improved by briquetting.

9. Briquets apparently give a longer flame than run-of-mine coal.*b*

10. It is much easier to raise and to keep up steam with briquets than with run-of-mine coal.*c*

11. Higher rates of combustion are possible with briquets and consequently higher power.*c*

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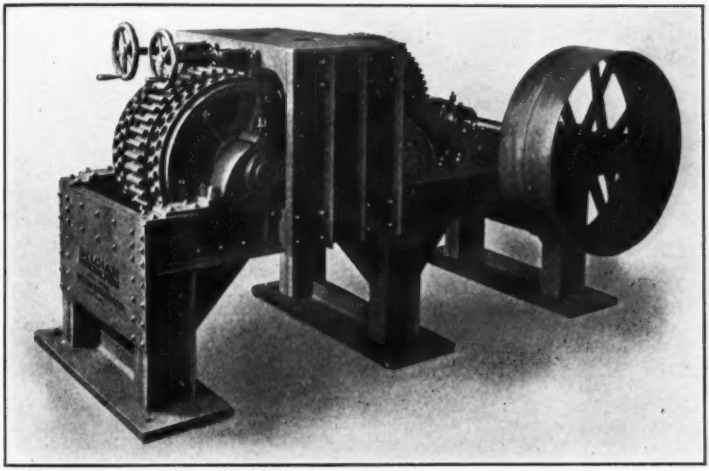
a Goss, W. F. M., in U. S. G. S. Bull. No. 363, "Comparative Tests of Run-of-mine and Briquetted Coal on Locomotives."

b Ray & Kreisinger, U. S. G. S. Bulletin No. 403, "Comparative Tests of Run-of-mine and Briquetted Coal on the Torpedo Boat Biddle.

c Ray & Kreisinger, U. S. G. S. Bulletin No. 412, "Tests of Run-of-mine and Briquetted Coal in a Locomotive Boiler."



BELGIAN EGGETTE PRESS.
Chisholm, Boyd & White Co., Chicago.

12. When properly made there is less loss from breakage during transportation of briquets than of run-of-mine coal.

13. The danger of spontaneous combustion in storage piles is eliminated if the fuel is stored in the briquetted form, and this characteristic of briquets has made briquetted fuel favored for storage by European countries.

14. The block-shaped briquets may be piled in regular piles and occupy less space than the run-of-mine or slack from which they were made.

15. Briquets, especially those made from lignite, have a higher heat value than the raw fuel from which they were made, this improvement resulting from the higher heat values of the binder added to bituminous and anthracite coal to briquet them, and from the evaporation of water from the raw lignite in the case of lignite briquets.

While the United States has been more fortunate than European countries in the amount of good bituminous and anthracite coal which it possesses, still the time is not far distant when the American people must realize that if the price of coal is not to reach such a high figure that the industries of the United States cannot compete with foreign industries, we will have to be more careful of what is now wasted in the process of mining; and then we may look for the gen-

WESTERN FUEL COMPANY'S BRIQUET PLANT, OAKLAND, CAL.
Equipped with Schorr presses.

eral adoption of briquetting as a partial solution of the problem of mine waste.

Briquetting schemes have failed in certain instances in the past because they were not under proper technical supervision, or the supply of raw fuel or binder was uncertain, or poor judgment was shown in the location of the plant to supply markets already supplied with good fuel at low prices. Most of the briquetting plants in European countries are located at the mines and are owned by the mine operators, so that they may utilize the waste from the mines, in the case of the hard fuels, or can make low-grade fuels such as lignites into briquets without transportation charges having been paid on the raw material.

Success in the fuel-briquetting industry in the United States will only be attained when American mine operators become sufficiently interested in this method of utilizing their mine waste, or, in the case of lignites, making a good fuel from inferior raw material, to install complete briquetting plants at their mines. With proper equipment and superintendence, plants so located should be a good investment for the operators.

Production of Briquets.

According to figures compiled by Mr. Robert Schorr, the world production of all kinds of briquets in the year 1885 was 4,750,000 metric tons, or 1.0 per cent of 475,000,000 metric tons, the total coal and lignite production of that year. The total coal and lignite production for 1908 was 1,035,000,000 metric tons and from this 26,000,000 metric tons of briquets were manufactured, or 2.52 per cent of

the total coal and lignite production for that year. This shows that the coal production of 1908 was 218 per cent of that of 1885 and the briquet production in 1908 was 549 per cent of that in 1885, so that in twenty-five years the coal and lignite production has a little more than doubled, while in the same period the briquet production has increased 5½ times.

The recent briquetting tests of the United States Geological Survey have determined that some American lignites can be briquetted successfully without adding binding material to them. These tests were made with an equipment imported from Germany especially for these tests. The heat value of the briquets manufactured was about 50 per cent greater than that of the raw material, this increase being due to the reduction in moisture by the process of briquetting. As about 1.4 tons of raw lignite was required to make one ton of the briquets, the net improvement in heat value of the lignite by briquetting was about 10 per cent. The cost of this briquetting, exclusive of the material for briquetting but including labor, power, depreciation, maintenance, and 8 per cent interest on investment, was estimated from these tests to be from $1.35 to $1.72 per ton of briquets, this figure applying to those varieties of lignites only, which can be briquetted without added binding material.

THE DESIGN, CONSTRUCTION AND OPERATION OF HIGH-LIFT CENTRIFUGAL PUMPS.

By Frank zur Nedden.

V. SPECIAL HIGH-LIFT TURBO-PUMPS.

Mr. zur Nedden's critical discussion of the centrifugal pump, the concluding part of which is here published, has already dealt with the mechanical and hydraulic losses of turbo-pumps, solutions of the problem of balancing axial thrust, structural features and manufacturing considerations, and the turbo-pump diagram and its practical interpretation in service. We now present his concluding section on Special High-Lift Turbo-Pumps.—THE EDITORS.

THE foregoing studies certainly show that the technical peculiarities of turbo-pumps, if ignored, might give rise to difficulties. If, however, the proper type is chosen, with full appreciation of these peculiarities, and if it is placed in proper working conditions, it is now proved by a larger number of plants that high-lift turbo-pumps are an ideal form of apparatus economically and especially in operation. Figure 42 shows the attractive appearance of a turbo-pumping plant. An excellent effect is secured by placing both suction and discharge pipes underground and the simplicity of operation corresponds to the external appearance. The compact arrangement of the turbo-pump is well shown in Figure 43, exhibiting a fine combination of a four-stage high-lift centrifugal pump by Messrs. Weise and Monski, with an 850 brake horse-power, three-phase alternating-current motor by the Bergmann Electricity Works. This pump is placed in the Karl Funke shaft of the Essener Steinkohlen-Bergwerks-Verein, and raises about 1,550 gallons a minute against a head of 1,200 feet at 1,480 revolutions.

I studied some interesting details of the space economy possible in a turbo-pump plant at one of the large coal mines at Upper Silesia. A Jaeger high-lift turbo drainage plant of 3,000 litres (670 imperial gallons per minute) was placed beside a piston pump of equal capacity.

Sections of the space required for each of the installations are shown relatively drawn to exact scale in Figure 44. Emphasis should be placed on the fact that the piston pump requires a concrete foundation 9 feet deep, while the turbo-pump could be placed on a simple

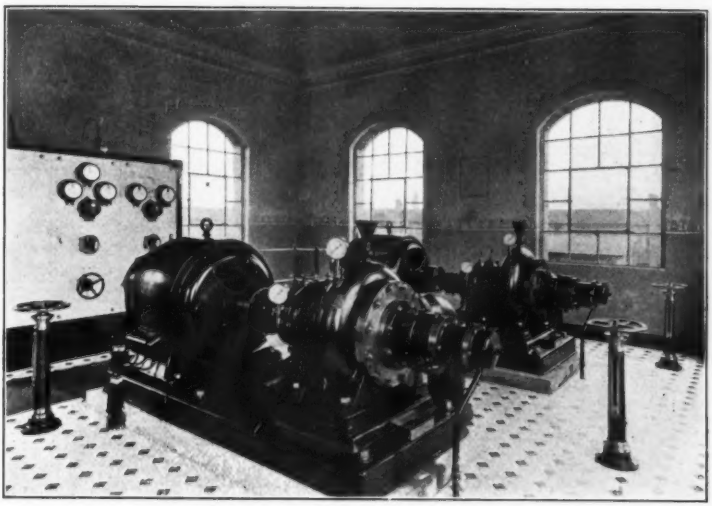


FIG. 42. TWO TURBINE WATERWORKS PUMPING UNITS, BERLINER MASCHINENBAU A. G.

flooring supported by I-bars, thus affording an excellent sump arrangement. Finally, it should be noted that as a rule in mines long narrow chambers are less expensive and safer against movement of the ground than broad high ones. The important influence of these considerations, which are by no means secondary, is illustrated by the following calculations. The thickness of masonry for the centri-

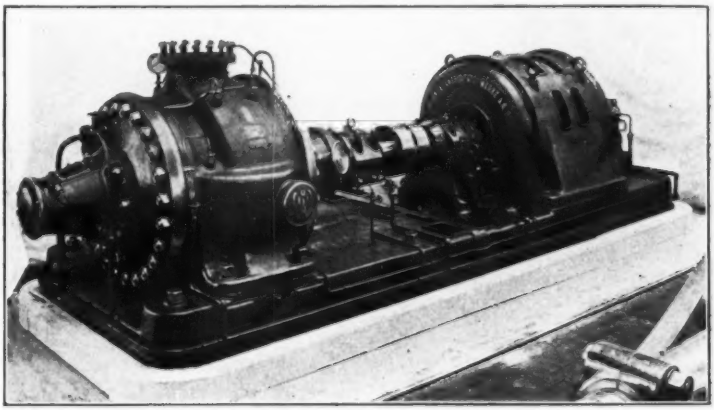


FIG. 43. WEISE & MONSKI FOUR-STAGE HIGH LIFT TURBINE PUMP DIRECT-COUPLED TO THREE-STAGE ALTERNATING-CURRENT MOTOR.
Lifting 1,550 gallons per minute against a head of 1,200 feet; 1,480 r. p. m.

fugal pump gallery was about 1.25 metres, while for the larger room provided for the reciprocating pump it was 1.50 metres. The cost figures for the installations are tabulated below:

	Piston Pump	Centrifugal Pump
Inside dimensions clear...	$6.9 \times 8.4 \times 22.5$ = 1,300 cu. metres	$4 \times 5.45 \times 11.5$ = 251 cu. metres
Additional for thickness of masonry	3 metres each way	2.5 metres each way
Resultant volume of rock to be blasted	$9.9 \times 11.4 \times 25.5$ = 2,875 cu. metres	$6.5 \times 7.95 \times 14.0$ = 723 cu. metres
Cost of blasting according to figures given by the management, 40 marks ($10 or £2) per cubic metre or in total	$2{,}875 \times 40$ = 114,700 marks	723×40 = 28,900 marks
Total volume of masonry..	2,875 — 1300 = 1,575 cu. metres	723 — 251 = 472 cu. metres
Cost of masonry according to figures given by the management 15 marks, (15 shillings or $3.75) per cubic metre or in total.....	$1{,}575 \times 15$ = 23,600 marks	472×15 = 7,090 marks
Total cost of pump room..	114,700 + 23,600 = 138,300 marks	28,00 + 7,090 = 35,990 marks
Difference in favor of turbo-pump		102,310 marks ($25,550 or £5,120)
Guaranteed efficiency of pump	92 per cent	68 per cent (intentionally assumed low; guaranteed 72 per cent)
Guaranteed efficiency of motor	90 per cent (slow speed)	92 per cent (high speed)
Total efficiency.....	82.8 per cent	62.6 per cent
Required brake power....	3,000 litres against a head of 540 m. static or 550 m. gauge. 326 kws.	do. do. with safety surplus of 3 per cent. 444 kilowatts
Difference to the disadvantage of the turbo-pump per hour of working.....		118 kilowatts

On the basis of 3 pfennig (¾ of a cent or a little more than a farthing) per kilowatt hour as given by the management of the mines, and of 3,600 working hours per year (calculated from aver-

age conditions) these 118 kilowatts represent an additional operating cost per annum for the turbo-pump of

$$118 \times 0.03 \times 3{,}600 = 12{,}700 \text{ marks } (\$3{,}175 \text{ or } £635).$$

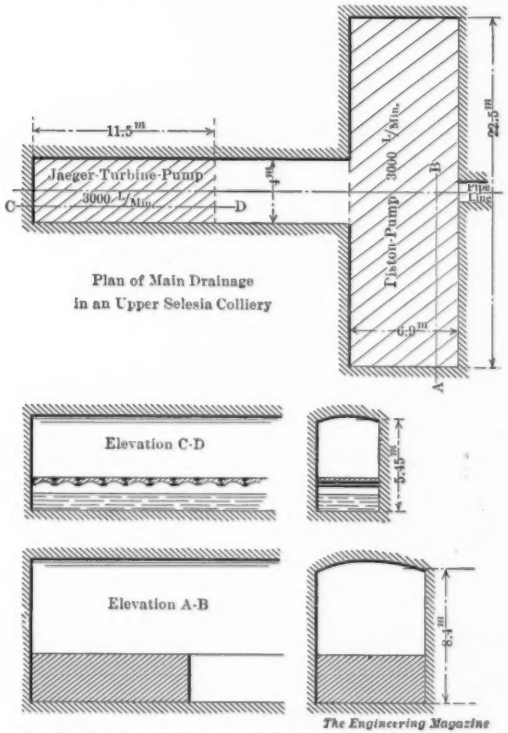


FIG. 44. RELATIVE SPACE ECONOMY OF TURBINE AND RECIPROCATING PUMP INSTALLATIONS.

The cost of the pump-room must be amortised at at least 5 per cent, and interest on its cost must be reckoned at 4 per cent, with an addition for cost of repairs estimated at 1 per cent. The total capitalization of this item, therefore, for purposes of comparative determination of operating costs must be taken on a 10 per cent basis. Consequently 12,700 marks additional expense for drainage by the turbo-pump correspond to a difference in invested capital of 127,000 marks. Therefore, there remains to the debit of the turbo-pump account an amount equal to 127,000 — 102,310 = 25,000 marks ($6,250 or £1,250). This, let us remember, applies to the pump chamber only.

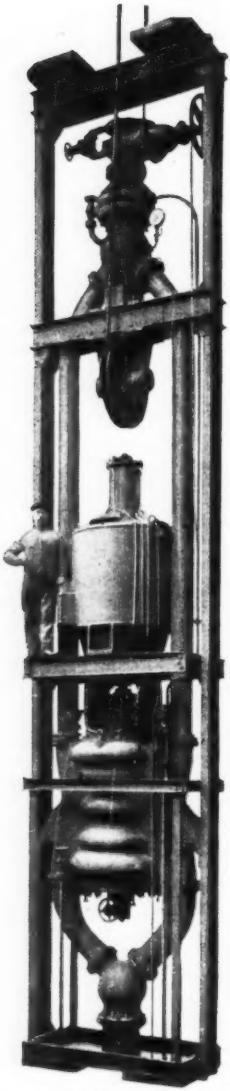


FIG. 45. SULZER MULTI-STAGE HIGH-LIFT TURBINE SINKING PUMP.

So far as machinery is concerned, the reciprocating pump combination costs about 97,000 marks ($24,250 or £4,850), while the turbo-pump combination costs only about 26,000 marks ($6,500 or £1,300). Even if we suppose that the turbo-pump will be used up in one-half the time which the reciprocating pump will last, there will nevertheless remain a difference of capital cost in favor of the turbo-pump equal to 97,000 — 26,000 × 2, or 45,000 marks ($11,250 or £2,250).

The total comparison of the roughly calculable capital or capitalization costs therefore leaves us with 25,000 marks to the debit of the turbo-pump and 45,000 marks to the credit, or a credit balance in favor of the turbo-pumping plant equal to 20,000 marks ($5,000 or £1,000). This calculation does not take into account costs of lubrication, repairs, wages, etc., which are decidedly lower with the turbo-pumping plant than with reciprocating pumps. Even though the bases of this comparison will be somewhat different in other countries and under other mining conditions, there still remains a balance of safety and convenience in operation in favor of the turbo-pumping plant, which no mining man should undervalue.

The compact arrangement of turbo-pumping combination becomes of incalculable value in the sinking of watery shafts. Sinking pumps of turbo form are arranged vertically. In spite of the apparent simplicity of design the difficulties in the construction of these units are immensely increased. Only a few builders have succeeded in mastering them. Among Continental firms Messrs. Sulzer Bros., of Winterthur, have been eminently successful. Figure 45 shows an example of their prod-

uct built for the Donnersmarkhütte, Zabrze, Upper Silesia. Its most striking peculiarity is that the first stage is placed at the top of the pump. Consequently the suction pipe must pass alongside of the pump to its highest point, whereas the discharge pipe ascends from the lowest point. To secure exactly symmetrical distribution of weight both pipes are divided into two branches and must be intertwined as shown distinctly in Figure 45. The principal advantage of this arrangement is that the axial thrust is upward, and if the dimensions are properly chosen it balances the weight of the rotating parts; that is, the impeller wheels, the rotor of the motor and shafts. The thrust bearing has to take up only shocks caused by sucking air or other incidents occurring often in the use of sinking pumps.

The pump shown in Figure 45 has attained a certain celebrity, being the first really large vertical sinking pump, and having saved by its excellence a valuable shaft. Prof. Herzog, of Zurich, outlines its almost dramatic history in an article on Sulzer high-lift turbo-pumps in the *Schweizerische Elektrotechnische Zeitschrift,* 1905. He says:

In the Donnersmarkhütte a shaft 400 metres deep was to be sunk. At a depth of only 100 metres springs were encountered so large that the miners had to flee and the shaft was flooded. While he was making his escape the mine foreman measured the rise of water, the calculation showing about 15 cubic metres per minute. Attempts to drain the mine by steam pumping had to be abandoned as unsuccessful, because in addition to needing many repairs the three steam pumps, which altogether raised 10 cubic metres per minute, filled the entire area of the shaft so that scarcely enough room was left for a bucket. The shaft was therefore again abandoned. To save if possible the loss of this valuable working, it was finally decided to give the Sulzer high-lift centrifugal pumps a trial. For this purpose three sets, (like Figure 45) were installed in the shaft, each delivering 8 cubic metres per minute to a height of 160 metres at 970 revolutions—a total delivery of 24 cubic metres per minute, while sufficient space for two buckets was still left in the shaft. Vertical alternating-current motors are used for driving. The weight of each suspended pumping set including the full delivery pipe amounts to 52,000 kilogrammes, giving a stress of 26,000 kilogrammes on each cable. These are steel wire ropes of 62 millimetres diameter.

Current is supplied from a power station 6 kilometres from the shaft in which two 1,000 horse-power gas engines, operating on furnace gas, were installed. The tension in the transmission line is 8,000 volts, which is transformed at the terminals to 1,000 volts.

Drainage was accomplished very quickly with these sinking pumps, as one unit alone on account of the small head at the beginning of the operations delivered 12 to 15 cubic metres per minute. Further, during the progress of sinking and blasting these pumps gave no trouble whatever. After the sinking was finished these pumps were fixed in the shaft and are now used as a stationary drainage plant.

The centrifugal pump is constantly conquering new domains. For example, it has begun to replace the reciprocating feed pump in large central power stations. It is especially suited to this service by its self-adjusted regulation and its ability to work for a certain time against the closed discharge pipe. It may be left quite to itself with a changing volume of feed-water delivery. Only in the boiler plants of electric power stations, where electric current may be obtained at low rates, will this type of pump be economical. As it is especially adapted to the delivery of small quantities of water against a high pressure it is often speeded to the highest point, even up to 3,000 revolutions a minute. Especially on ship-board it has lately been adopted to an ever-increasing extent because of its small weight and space requirements.

One of the most interesting special uses for the turbo-pump is the supply of water under pressure for the service of heavy hydraulic machinery in rolling mills and similar works. A very valuable advantage of the turbine pump in this service lies in the fact that a troublesome accumulator system is no longer needed and the turbine pumps may be connected to the piping system without any intermediary appliances. Only in very large systems in which the length of the pipe lines (and consequently the quantity of water contained therein) is very great does it become advisable to protect the pump from the violent reactions caused by the acceleration and retardation of the large water column when the governing valve is suddenly opened and closed, as it so frequently is in rolling mill work. Special protective arrangements are then applied. Their features as well as the choice of the most suitable form of blades (a matter of extreme importance in this kind of work) are carefully guarded secrets with the very few prominent firms who have learned them by large experience. When these precautions have been observed, the operation becomes almost ideal. A whole room full of hard-working piston pumps, with all the intolerable difficulties which valves for pressure of 50 atmospheres and more always occasion, is replaced by a single electric-driven turbo-pump combination. It requires one machinist instead of half a dozen, and runs uninterruptedly day and night for many months without requiring the smallest repairs. For, given pure water, the turbo-pump under continuous operation without stoppage finds its best working conditions, as all strains are in the form of steady or dead load and do not differ from the conditions of rest.

TIME KEEPING AND LABOUR DISTRIBUTION IN THE FOUNDRY.

By Victor R. Claydon.

The policy and methods of foundry management proposed by Mr. Claydon are extremely simple and reasonable. They require no burdensome increase of "paper work." Nevertheless they are sufficient to provide considerable knowledge of pertinent and valuable facts about the location of the profitable and unprofitable parts of a business, and the actual value received for every dollar expended. His article now published will be followed next month by one upon "The Handling of Stores"; in July he will discuss "Keeping Down Foundry Expenses."—THE EDITORS.

COMPETITION is the most insistent fact in the experience of the business man of today. From the small jobbing shop up to the large locomotive works, the cry is the same: "We cannot make the headway we used to;" and naturally the inquiry is: "What is the reason?" "Times change and we change with them," said one of the wisest of sages; yet I venture to think had he been living now his adage would have read "Times change and we *do not* change with them." This, in my opinion, is at the root of a good deal of our loss of business. Some of us are still content to run along the old lines, for the very intelligent (?) reason that "My father made a good living out of it, and I can do the same." Unfortunately, however, this theory does not work out in practice. To go with the times means to be up to date; and this in turn means that a manufacturer must know with certainty, at any time, how his business is progressing. This can be accomplished only by looking after the details, which perhaps when competition was not so rife our forefathers could afford to let slide. In these days of "hustle" it does not do for us to stand and wonder why our business is not flourishing—it is "up to us" to know; and it is only by a systematic handling of our affairs that we are enabled to detect the many leakages that exist, and effect economies compatible with efficient management.

Apart from the diverse opinions held by cost accountants as to the working out of a cost system, business men themselves are very sceptical about undertaking any so-called "innovation," especially when they get the idea that it means the employment of what they are pleased to call "non-productive" labour for its efficient carrying

out. They lose sight of the fact that with a proper cost system in force, as has been proved in countless cases, they will be able to effect considerable financial saving, and to make their business a thoroughly profitable concern. It is no uncommon remark that a cost system involves too much red tape. Superficially it does; but when accurate results are obtained it becomes of vital importance, especially, as I have pointed out, when we are able to effect economies which but for our cost system, we would never have dreamt of effecting. Provided, then, these conclusions are reached, our "non-productive" labor becomes surely very profitable, if not from a manufacturing point of view "productive."

In this article it is my intention to point out the necessity of an accurate record being kept of foundry employees' time, and a proper distribution being made of the work performed by them in a given period. Many an employer of labor is confronted with the statement that during the financial year $100,000 has been spent on wages alone in his establishment; and often, too, the knowledge comes as no small surprise, unless he has details at hand showing what return he received from his employees for this output; and he may very reasonably wonder whether this amount has actually been earned by those employed by him. On the other hand, however, if you were to ask an employer if he thought his employees had turned out the best results for the money paid them he would in all probability greet you with the remark that he was not such a fool as to pay for what his men did not earn. But is he sure of this? In a large manufacturing plant it is very easy for loose and inefficient methods to prevail unless a very strict watch is kept upon everything. Obviously, then, it is a necessity that we have some arrangement whereby we are able to keep tab on our employees, and thus see that we are obtaining a just return for our expenditure. "Waste not, want not" is a very old proverb, which it might be well for us to consider a little more—especially in a foundry business where the opportunities for waste are so enormous.

In a foundry of any magnitude it will be conceded that a timekeeping system of some kind is an essential. Various systems are in vogue, each one doubtless having its own peculiar advantages. For instance, the "metal check" system is considered by some to be a good method. Under this plan, a successful applicant for work is entered on the pay-roll sheets under a given number. On his starting to work he applies to the timekeeper for a check bearing his number, without which he cannot even enter the shops. On his arrival

at his particular workshop he deposits this check in a box in his shop provided for the purpose. This box is in charge of the foreman of the department (or an assistant timekeeper) whose duty it is to lock up these boxes immediately after the whistle has blown for starting work, the timekeeper at the same time shutting his wicket. A late arrival has to apply in the office for his check, the timekeeper noting in his book the time at which he starts work. Now whilst not altogether condemning this method, I would like to point out what appear to me to be its weak spots. In the first place, it would seem that too much time is taken up by the timekeeper in arranging and giving out these checks at certain intervals during the day. As you will readily see, the same process has to be gone through at the lunch hour and also on the men quitting at night. Again, where a large number of hands are employed it is practically impossible for a shortage in a man's pay to be satisfactorily determined under this method. What I mean is this: assuming that after the men have been paid, one of them reports to the timekeeper that he is short paid, the time sheets are turned up, and it appears as far as the timekeeper's books show the man has been correctly paid, whilst it is not at all improbable that the man's money was not correct, and an injustice was done him, which under the metal check system it is impossible to detect.

Once again:—in addition to the two objections I have already pointed out, I think that there is a great opportunity for a timekeeper to show favoritism if he should so desire, and with slight chances of detection; this is surely a very strong disadvantage of this system. There seems to be no reason whatever why the time clerk cannot, if he so chooses, show partiality to any particular "friend" he may have in the works. For example, what is there to prevent this official from entering up in his book 10 hours for which a man did not work? What means have you of detecting this fraud? Doubtless if it was carried on to any extent it would be found out, but "prevention is better than cure."

We often say "What can't speak can't lie;" and this leads me to speak of the time clocks, which are being used in plants more and more every day. I think it is scarcely necessary for me to go into details as to the mechanical working of these, as most of us are acquainted with them, although we do not make use of them. As far as I can see, however, their method of registering a man's time leaves very slight chances of dishonest practises, and as far as day workers are concerned none of these should be short in their pay. On entering the works in the morning, a man goes first thing to the

Machine Shop. PAY ROLL FOR FORTNIGHT ENDING December 25th 1909

No.	NAME	RATE	15 W	16 T	17 F	18 S	19 M	20 T	21 W	22 T	23 F	24 S	25 M	26 T	TOTAL HOURS	ADVCS.	SUBS.	AMOUNT	REMARKS
317	J. Thompson	2.25	10	10	10	10	10	10	10	8	7	–	–	5	90	–	–	20 25	
318	W. Arnott	2.00	10	9	10	8	–	10	7	5	10	–	7	3	Piece Work	–	–	26 18	as Piece Work shts
319	H. Jones	2.50	10	10	10	5	10	10	10	10	10	–	10	10	105	–	–	26 25	

FORM FOR PAY ROLL. The Engineering Magazine

clock and punches his time, on the number by which he is known on the pay-roll sheets. This in turn registers on a slip, affixed inside the clock, the exact time at which he entered the works. Assuming that 7 a. m. is the recognised time for starting work, the clock watcher (possibly a trusted employee) at (say) three minutes past the hour, will lock the clock, and by moving a lever on the face of it he places the disc in position for the men to punch when they stop work at the noon hour. The same process is gone through on their return, and on quitting work at night. At the end of the day this clock slip is removed by the timekeeper, and a new one placed in position for the following day. Now on examining the clock slip we find a record somewhat similar to the following:—

No. 56. 6-45. 12-01. 12-57. 5-32.

Here, then, is a true record of the time actually worked by the man corresponding to No. 56. In the event of an employee omitting to punch his time at any of the recognised hours, the error would at once be detected by the timekeeper and enquiries made as to the reason, a repetition thereby being prevented. Having thus far seen the part to be performed by the men, our next step will be to follow the clock slip into the time office where the pay-roll sheets are made up. Here again several systems of entering up the pay roll are in force, one of which is to paste the actual clock slips into a book specially ruled for the purpose; but personally I do not think this the best method. I submit in

its place therefore a sketch of a pay-roll sheet which has been found to work well, and obviate a lot of duplicate work. (See opposite page.)

In some business places I have visited, the men's time was first entered in a time book, and at the end of the pay period the total number of hours worked by each man was put on the pay-roll sheet. In the sketch shown above you will perceive we have a time book and pay roll all in one. Perhaps someone might ask "Why not paste the actual clock slips in a time book as hinted before?" My idea is that it takes longer to do this than the way I advocate. In the first place, the hours have to be extended on the clock slip. Then this again has to be cut into strips the size of the book and pasted in. Moreover, in the event of a new man starting on the same number as a man who has left during the pay period, there is no room to record the two different names, as naturally to suit the clock slips the spaces between each two numbers are very narrow.

We have now our method of recording the men's time, but in addition to our day workers, there are our piece workers, and although it is interesting and necessary to keep track of their time, yet of course the important part is to keep track of the work performed by them, as it is by this that these men are paid.

In a large manufacturing plant, especially where various lines of castings are made, it is by no means an easy task to keep correct records of the work performed by our piece workers. A plan similar to that outlined hereunder is one I have seen in operation in a large plant, and it has been found to work well. (For the purpose of illustration we will assume that we have no night gang to clear the moulders' floors, and that the castings are cleared first thing the morning after the cast.) On the afternoon of the cast the timekeeper or one of his clerks would go round to each of the molders and core makers and enter up in his rough piece work book the pieces made by the respective men. This piece work book would be ruled after the manner shown on the following page, which for convenience of reproduction within the page limits shows ruling for 10 days only.

As far as the cored work is concerned it is practically impossible for a man to be paid for more than he has made, as obviously the cores would have to balance the number of pieces given in by the moulder, and *vice versa*. On the following morning, the clerk would check up the pieces in the foundry before their removal to the cleaning shop, thus ensuring that he has all his work correctly entered. While doing this he can of course discount any bad pieces which have been made against the workmen responsible for them. As will

BAD CASTINGS											GOOD CASTINGS										
(Date)	1	2	3	4	5	6	7	8	9	10	Description	(Date)	1	2	3	4	5	6	7	8	9	10
											#52 T Irons											
		-	1								Nr 3 Fire Pot		1		2	3						
											Bells		6		10	9						
				6							Touch wheels		7		3	1						
				2																		
											#16 W Smiths											
											Nr 4 Fire Pot		2		2	2						
											* Duration of Loose											

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FORM OF RULING AND ENTRIES IN ROUGH PIECE-WORK BOOK.

doubtless be observed, this rough piece-work book (see sketch) serves the double purpose of a record for good and bad castings. As soon as this work is completed the clerk can enter up this work on his "fair copy" piece-work sheets—that is, the sheets from which the piece workers are paid. In all probability, too, we shall have day workers in the foundry, and it is necessary that the work performed by these men be not lost sight of, as very often it is these day workers who run up our burden charges. We know from experience that a day worker, generally speaking, does not perform so much work as a piece worker. Again, presuming he turns out defective castings, it is the foundry which has to stand the whole of the loss. For the purpose, then, of keeping such records the day worker should be supplied with a time card on which is indicated the work he is engaged on, and the time he started it. On completion of this particular job he will bring his card to the timekeeper, who will mark on the card the time the job was finished, also extending the cost at the man's rate per hour. By this means we get the actual amount paid for the moulding or core of any casting, which is certainly of great value in compiling our cost records.

So far I have dealt only with the methods of timekeeping and the advantages which accrue from carefulness on the part of the clerk whose duty it is to look after this work. But all this is only a means to an end. Whilst all the information we get from the time cards

and piece-work sheets, etc., is very necessary and of great assistance generally, it is incomplete in this state. As I said at the beginning of this article, if we are to know exactly how our wages have been expended we must distribute the monies earned by our employees over the specific jobs on which they have been engaged; then and only then, have we some tangible evidence to go on, which will undoubtedly show us whether we are getting a just return for our expenditure, and also show us where the leakages exist, and enable us to remedy them. This without doubt is the most important thing in any business. We are all more or less aware that these leakages do exist, but to arrange our work so as to be able to spot them at once is of inestimable value to the prosperity of any business. Before we can distribute our pay roll, however, we must have a classification of the accounts* which we wish to keep a line on—that is, a symbol for each of our staple lines of manufacture, and our maintencance charges, etc.

At first sight, perhaps, one might be tempted to imagine that the distribution of a man's time, over the several jobs would be a simple matter, necessitating only the copying off of the charges as turned in on our day-work time cards and piece-work sheets; and apportioning the monies as per our classification. On examination, however, we shall find this to be much more difficult. For instance, the clerk who does this work must necessarily be thoroughly cognisant of the work being done in the shops, and thus be in a position to charge up correctly the hundred-and-one jobs that go through the foundry in the course of a day. Hitherto I have confined myself to speaking of the foundry only, but I think my remarks will be found more or less applicable to the several shops that go to make up our entire works. Our machine shop is in all probability a more complicated shop to deal with than our foundry, as it is here that most of our repairs to plant, patterns, etc., are done. We cannot depend upon workmen to symbolise their particular work correctly on the time cards, and sometimes it happens that they do not even know what the job is that they are working on. In order to illustrate our method of distributing the pay roll, let us classify our shops as follows:— A = Foundry. B = Core Shop. C = Machine Shop. D = Pattern Shop. E = Warehouse, an so on; and let our staple lines of manufacture be classified as follows:— 1, Boilers. 2, Steam Fittings. 3, Jobbing. In addition to these we will have our maintenance charges

* For a splendid outline of a foundry classification I would refer my readers to the one given by Mr. C. E. Knoeppel, in his articles on Foundry Costing, which appeared in THE ENGINEERING MAGAZINE October, 1908-March, 1909.

which we will number thus:— 14. Maintenance of Buildings. 15. Maintenance of Machinery. 16, Maintenance of Tools. 17, General Shop Expense, etc. With this information in mind we will now proceed to distribute the pay roll; and I would commend the method of distributing each man's pay in each shop separately. As you will see by the sketch, along the top line we have the symbols indicating the nature of the work performed by the respective men. At the extreme left of the next lines we enter the numbers of our men as they are known on the pay rolls, and in the balance of the columns we enter up the amount of money expended by each man on each job as per our time cards and piece-work sheets.

GENERAL FOUNDRY DISTRIBUTION OF PAY ROLL, PERIOD ENDING Feb. 1910

MAN'S NO.	14A	14B	1	2	3	16C	17D	17E				TOTAL OF MANS PAY
7	1·10	1·05	7·62	1·85	9·27	·45	·22					21·56
8			8·18	22·14	1·10							31·42
9	1·5		18·20	2·25	8·10		1·05	·75				30·50
10												
11												
											The Engineering Magazine	

FORM FOR GENERAL DISTRIBUTION OF FOUNDRY PAY ROLL.

It may possibly be asked "what is the object in having each man's pay separate?" My answer is that by this means it is easy for the distribution clerk to turn up his sheets in case of error, and he is enabled to spot the error at once, without having to go through perhaps hundreds of time cards in order to find the mistake. Moreover, it enables a checker to spot any wrong charges, etc., and if a foreman wishes to know what a certain man has done on any particular job, this information can readily be obtained if a method similar to the one outlined is adopted.

DIRECT CHARGES	1	2	3					
General Foundry	1865·10	976·19	427·86					
Core Shop	981·22	422·15	120·16					
Machine Shop	1227·09	526·47	195·26					
Pattern Shop	200·18	106·15	90·65					
Warehouse	77·16	10·20	1·05					
	4350·75	2341·16	834·98					
	The figures are imaginary						The Engineering Magazine	

FORM FOR DISTRIBUTION OF DIRECT CHARGES TO THE SEVERAL SHOPS.

We have now obtained a proper distribution of our pay roll according to the shops in which the men have worked, but we must go a step further to obtain the information as to the amount of money which rightfully belongs to the individual shops—i. e., the amount of direct labour chargeable to each shop, and also its own burden charges. To arrive at these details I would suggest the use of the charts at the foot of page 228 and the one following:—

FOUNDRY BURDEN	A14	A15	A16	A17					
General Foundry	25·15	95·01	7·65	15·81					
Core Shop	5·08	36·22	3·32	2·25					
Machine Shop	16·91	98·17	15·72	13·26					
Pattern Shop	4·72	2·10	3·22	4·09					
Warehouse	1·05	–	2·77	2·50					
Total Foundry Burden	52·91	231·50	32·68	37·91					

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Charts similar to these should be used for each department. By working our charges out on this principle, we arrive at the total amount of our direct charges, and also the amount of burden chargeable to each shop. It does not take much to see of what immense value the figures charted in this way are to us. Primarily they enable us at a glance to notice any undue expenditure on any particular charge. In many manufacturing concerns the upkeep of patterns is no small item, and unless such a department as this is carefully looked after it soon becomes our "graveyard."

Having now our final figures, we can (as you will notice) trace any particular part of them right back to their origin, which I venture to say is a fact worthy of our consideration.

There are, and always will be conditions, prevailing in foundries that must necessarily govern a good many of our actions in costing, yet I trust that this paper will be of interest and helpful at least to some foundry managers and officials. The next article will take up "The Handling of Stores."

A PRACTICAL STUDY OF POWER COSTS.

By William O. Webber.

IT has always been astonishing to me that the power user generally knows so little about the actual cost of his power. This failing seems to be especially common to the management of department stores, although the managers of manufacturing plants in general are nearly as ignorant.

Some time ago, I elaborated a scheme for ascertaining what the costs were in a number of department stores, with suggestions as to the installation of new machinery to reduce the costs of some of the items. I present here a copy of the report which I made at the time, showing the equipment of such a plant, how the actual costs were arrived at, and what they were, with suggestions for the future.

It will be noted that the average cost per car mile for elevators is 29½ cents. Now in another department store in an exactly similar building not a block away from the first example, the cost per car mile for elevators doing similar service was 73 cents, whereas the weight of steam used per horse-power hour on elevators was 43 2/10 pounds in the first instance and 45 5/10 pounds in the second instance. At first sight the difference in cost per car mile seems inexplicable.

In the first instance, the total cost of the elevator system per annum, including interest and depreciation, is $9,022, while in the second instance the total cost was only $4,252. The mystery, therefore, becomes more profound, until we find that in the first instance the total mileage is 27,000 miles, and in the second instance only 5,816 miles. There was then about one-fifth of the mileage in the second instance that there was in the first instance, or a speed of nearly three-quarters of a mile per hour in one instance and three-eighths of a mile per hour in the other instance; there you have the milk in the cocoanut.

The remedy for the case where the elevator cost per car mile is 73 cents is obviously increased mileage; but if there is no demand for this increase of mileage, the only other remedy, (the elevator pump having a capacity of 140 horse power, while only 62½ horse power is demanded), is to compound this elevator pump so as to reduce the cost of its operation. This saving would amount to $604.75 per annum, reducing the cost to a little less than 63 cents per car mile.

It is interesting to note also the similarity in the cost of power per horse-power hour as follows:

Total Horse-Power Hours.	Cost per Horse-Power Hour.
1,234,946	1.9
425,129.3	2.13
885,980	1.86

In this last instance, where the elevator load amounts to 566,060 horse-power hours per annum, the elevator cost per car mile is only 23 cents.

Another interesting point is that these figures show beyond any question the high consumption of coal per horse-power hour, the first plant showing 4.2 pounds, the second 4.55 pounds, and the third 5.25 pounds, without any coal for banking; with banking coal these figures would be 20 per cent higher. The boiler load in the latter case was 310 horse power, which corroborates my power figures.

These several plants show the cost of electric lights, including both incandescent and arc lights, to be 2½ cents per horse-power hour, (or a quarter of a cent per 16-candle-power hour) in one instance; 2.3 cents (equal to 0.23 cents per 16-candle-power hour) in a second instance, and 1.39 cents (equal to three-sixteenths of a cent per lamp) in a third instance. These are particularly interesting in view of the fact that 81,700 16-candle-power lamp hours purchased outside cost $1,037, equal to a cost of 1.27 cents per lamp hour, while electric-light-station data show an average cost per electric horse-power hour of .848 cents, equal to .0848, or a little less than 3/32 of a cent.

The pneumatic cash system cost 1.30 cents per horse-power hour in one instance, and in another case 2.71 cents per horse-power hour; this difference is due largely to the difference in size of plant.

With these figures it is interesting to compare the power costs in a manufacturing establishment, where the lighting load is 2.75 cents per horse-power hour, but the total cost of all the power is 1.24 cents per horse-power hour.

The coal consumption is 3.38 pounds per horse-power hour, and the steam consumption 23.24 pounds per horse-power hour, with a total load of 1,747,108 horse-power hours.

Still further, it is of interest to compare all these figures with the figures recently obtained by me from a gas-producer and gas-engine generating plant, with a total annual load of 534,400 horse-power hours. With coal at $6.00 per ton, the total cost was 1.3 cents per horse-power hour, or about one-eighth of a cent per lamp hour at

half load, which would again be equal to 0.83 cent per horse-power hour at full load, so that with coal at the following price we are safely assured of the following cost per horse-power hour at full and half load:

Cost per Ton.	Cost per Horse-Power Hour, in Cents. Full Load.	Half Load.
$1.00	0.462	0.94
2.00	0.537	0.97
3.00	0.600	1.08
4.00	0.680	1.164
5.00	0.75	1.25
6.00	0.828	1.35

Below I give a typical report in detail, showing the data observed, the costs recorded, and the manner in which the results were analyzed:

Date.....

Building corner of Blank and Blank streets, owned by Blank & Company and occupied by Blank & Company as a department store.

BOILER CAPACITIES.

Three Heine boilers, 220 horse power each, or a total of 660 horse power.
Steam pressure, 110 lb. Draft, ¾ inch water.
Grade of coal used—Pocahontas, run of the mine.
Coal consumed—13,800 lb. daily in summer, 19,100 lb. daily in winter. Total coal consumed per year, 2,600 tons.
Average price per ton, $3.00.
Cost of ash removal per year, $303.00.
Boilers are used for supplying steam to twelve elevators, four electric-light engines, three blowing engines, steam pumps and air compressors.
Building is heated by exhaust steam using the Paul system, drips connected to traps and return tank.

ENGINE CAPACITIES.

Four 13 by 12 high-speed Ames engines, 275 revolutions per minute, 125 horse power each, or a total of.....500 horse power.
Engines direct-connected to electric-light generators. An average of two of these in use at once. Average..156 horse power.
Three 11 by 12 double, inclined Buckeye engines, 89 revolutions per minute, 60 horse power each, or a total of .....180 horse power.
These engines are direct-connected to Root blowers supplying air to pneumatic cash system. An average of two in use.....116 horse power.
Two 6 by 8 elevator engines, 125 revolutions per minute, 10 horse power each, or a total of..... 20 horse power.
These engines direct-connected to drum elevators. Average .....15.5 horse power.
One 6 by 9 centre-crank engine..... 10 horse power.

PUMP CAPACITIES.

Two Davidson elevator pumps 22 by 13 by 22, 65 horse power each, or a total of.....130 horse power.
These pumps furnishing power to nine hydraulic elevators under 115-lb. pressure. Both pumps in use.
Two No. 6 Davidson boiler-feed pumps 10 by 6 by 12, 8 horse power each, or a total of....16 horse power.
One of these pumps in use..... 8 horse power.
One No. 5 Knowles pump, 6 by 5½ by 7, pumping water for sanitary purposes to tank at top of building.....64 horse power.
(Fire pumps, etc., only operated on emergency.)

DYNAMO CAPACITIES.

Four General Electric, multipolar type, direct-connected dynamos, 115 volts, maximum capacity 75 kilowatts...400 horse power.
average load .....130 horse power.
Supplying current to electric lights.
One motor, 2 kilowatts, about.....3.5 horse power.
Operating electric elevators for bundles.

ELEVATORS.

Nine hydraulic elevators as follows:—

1	26	-in.	cylinder,	7	ft.	8	in.	stroke,	gear	10	to	1,350	ft. per min.
1	24	"	"	7	"	8	"	"	"	10	"	1,350	" " "
2	13.5	"	"	25	"	6	"	"	"	3	"	1,315	" " "
1	40	"	"	6	"	7	"	"	"	10	"	1,350	" " "
1	12.5	"	"	25	"	6	"	"	"	3	"	1,218	" " "
1	8.5	"	"	10	"	10	"	"	piston			350	" " "
2	10.5	"	"	26	"	3	"	"	gear	2	"	1,230	" " "

2 direct-acting drum steam elevators, maximum hoisting speed, 150 ft. per minute.
1 electric elevator for bundles.

ELECTRIC LIGHTS.

1,200 16-candle-power incandescent lights.
286 arc lights = 1,710 incandescent lights.
Equal to 2,910 " " = a total of 291 horse power.

AIR COMPRESSORS.

Two Westinghouse air-brake pumps, 16 strokes per minute, 50 lb. pressure, 4 horse power each, or a total of 8 horse power.

ESTIMATE OF POWER USED.

Average boiler power for supplying steam engines.....300 horse power.
Average boiler power for supplying steam pumps.....168 horse power.
Average power from engines operating Root blowers...116 horse power.
Average power from engines operating electric light generators .....168 horse power.
Average power from engines operating steam elevators.13.5 horse power.
Average power required to operate hydraulic elevators 130.8 horse power.

Total elevator load	1628.2	h. p.	hrs.	per	day	=	504,742	per annum.
Total electric light load	1310	"	"	"	"	=	405,864	" "
Total load of cash system	1044	"	"	"	"	=	323,640	" "
Pneumatic pressure load		"	"	"	"		500	" "
Sanitary water	"	"	"	"	"		200	" "
							1,234,946	per annum.

OPERATING EXPENSES. PER YEAR.

2,600 tons of coal at $3.00 ton	$7,800.00	
Removing ash	303.00	
		$8,103.00
Engineers and firemen, 52 weeks at $109.	$5,668.00	
Electrical staff = 52 weeks at 60.	3,120.00	
		$8,788.00
Repairs on engines	$50.00	
Water for mechanical purposes, 815,000 cu. ft.	1,002.00	
416 gallons engine oil at 25 cents	104.00	
260 gallons cylinder oil at 42 cents	108.00	
2,000 lbs. of waste at 7½ cents	15.00	
100 lbs. packing at 25 cents	25.00	
5 per cent interest on $36,825 = estimated cost of present plant	1,841.25	
5 per cent depreciation on $30,000	1,500.00	
		$4,645.25

ELECTRIC-LIGHT EXTRAS.

Repairs on dynamos and motors	$60.00	
Lamps 400 per annum at 18 cents	72.00	
Carbons	1,528.00	
		$1,660.00

Total cost of light, heat and power $23,196.25
Total cost of all power used per horse power per hour, 1.88 cents.
Pounds of coal per horse power per hour for total power used... 4.02 lb.
Pounds steam " " " " " " " " " ... 41.8 lb.

ELEVATOR SYSTEM COST.

Total cost of elevator system per annum including interest and depreciation $8,016.00
equal to 1.6 cents per horse-power hour.
Total mileage of elevator system per annum ..... 27,000 miles.
Average cost per car mile ..... 29½ cents.
Pounds coal used by elevators per diem ..... 6,880 lb.
Horse-power hours on elevators per diem ..... 1,628 horse-power hours.
4.15 lb. of coal per horse-power hour.
Rate of evaporation on boilers ..... 10.4 to 1.
Pounds steam used per horse-power hour on elevators... 43.2 lb.

ELECTRIC LIGHT SYSTEM COST.

Total cost of electric light load per annum, not including carbons consumed in arc lights $10,936.00
Total cost of electric light load per annum, including carbons consumed in arc lights 12,192.00
Total lamp hours per annum (without carbons), 405,864 = 2.50 cents per horse-power hour, or .25 cents per 16-candle-power hour.
Total lamp hours per annum (with carbons), 405,864 = 3. cents per horse-power hour.
Total coal per diem ..... 5,483 lb.
Electric light load per diem ..... 1,310 horse-power hours = 4.18 lb. coal per horse-power hour and 43.3 lb. steam per horse-power hour.

CASH-SYSTEM COSTS.

Total cost of cash system load per annum.....$4,515.00
Total horse-power hours = 323,640 = 1.39 cents per horse-power hour.
Total coal used.....1,080 lbs. per day.
Total load of cash system per day.....1,044 horse-power hours.
Remarks:—
Total cu. ft. of space in building.....4,000,000
Horse power of steam necessary to heat building.....265

NEW INVESTMENT.

ELECTRIC-LIGHT MACHINERY.

Four 3-cylinder 93-kilowatt gas engines installed complete	$20,000.00	
Foundations, piping, etc.	2,000.00	
		$22,000.00

ESTIMATED NEW EXPENSES.

OPERATING ELECTRIC LIGHTS BY GAS ENGINES.

Repairs on engines (four)	$50.00	
Water for engines	20.00	
Oil, waste and supplies	30.00	
Repairs on dynamos	60.00	
Lamps and renewals, 400 at 18 cents	72.00	
Labor—dynamo and electric light man = 52 weeks at $20.00 week	1,040.00	
Depreciation 5 per cent on $20,000.00	1,000.00	
Interest at 5 " " " 22,000.00	1,100.00	
		$3,372.00
405,864 horse-power hours using gas at 1 cent per horse-power hour	$4,058.00	
For incidentals	110.00	
		4,168.00
		$7,440.00
Present cost of electric lights, not including carbons	$10,036.00	
New cost of electric lights, etc	7,440.00	
	$2,596.00	
Showing a saving on electric lights of		$2,596.00
or including interest on value of old steam engines displaced = $200 per annum, the saving in electric lights would be		$2,396.00

GENERAL REMARKS.

The present cost of operating the hydraulic elevators equals	$8,016.00	per annum.
together with cash system equal to	4,515.00	" "
	$12,531.00	per annum.

As the steam used for these purposes equals 284 horse power and is just about enough to heat the building, this amount should be equally divided between work done and the heating, so that either of them should be charged with $6,265, and at that low cost it would not be profitable to make a change in the method of operating the elevators and pneumatic system.

It would pay, however, to make the change in generating electric power from steam to direct-connected gas engines, as the steam from these engines is practically in addition to all that is required for steam heating, and therefore the total cost of the steam used in these engines must be charged to the lighting. The difference in favor of generating electric light by gas instead of steam would be $2,396 per year after charging off $2,300 per year for interest and depreciation on the new machinery necessary to utilize the gas, and old engines. I would suggest the replacement of two of the present steam engines direct-connected to generators, by two gas engines of sufficient size, in which case the interest and depreciation amount would only be $1,150 per year instead of $2,300, and a net saving of $3,834 over the present system would be shown; this would be sufficient to furnish all the lights excepting on the very darkest days in the winter, which are also the coldest, and the steam from one of the remaining two electric-light engines would then be partially utilized for heat.

APPLICATION OF LOW-PRESSURE STEAM TURBINES TO COMPRESSOR WORK.

By J. W. Sheperdson.

Mr. Sheperdson's paper is the outcome of some very interesting figures arrived at in a special case. It is valuable as showing the possibilities of increasing the output and efficiency of existing steam plants by the use of low-pressure turbines driving compressors, and it contributes to better knowledge of an important relation of power-plant economy—the relation of the turbine as an adjunct, rather than a competitor, to the reciprocating engine.—THE EDITORS.

IT is today generally admitted that the low-pressure turbine offers a ready means of increasing the efficiency of existing engine plants, especially if concurrently an increase in output is required. Much has been written about low-pressure turbo-generators and their application. Many installations of low-pressure turbo-generators have been completed, tested, and put into successful operation, bringing in their trail very attractive economies. The combination, however, of reciprocating engines with low-pressure turbines as the last expansion stage has not yet reached the point where it is undoubtedly the best policy to pursue in new installations, because the simplicity of the all-turbine steam plant has too many advantages to overbalance the slightly better economy of the combination. The field of the low-pressure turbine will remain for the present in converting inefficient engine plants into economical ones.

The low-pressure turbine as a prime mover can be applied only to machines which can convert mechanical energy of rotation into work. Electric generators have been successfully driven by steam turbines, especially when these generators are electrically locked with the generators of reciprocating machines and when the low-pressure turbine constitutes in effect the last cylinder of the engine. Recently considerable has been written about turbo-air-compressors, and it will be the object of this article to study the application of these machines to this work.

Prior to going into the comparison of the performances of air-compressing plants, it would be well to outline the basis which it is intended to use in the following deductions:—

The ratio of output to input (expressed in the same units) in any machine constitutes its efficiency. The ratio of output of an air compressor, in indicated air horse power, to input in indicated steam horse power, gives the mechanical efficiency of the machine. This efficiency is only a measure of the mechanical losses.

Air compressors are built in multi-stage form with cylinder jackets and inter-coolers, in an effort to approach as nearly as possible isothermal compression, which represents the minimum work. An efficiency based on isothermal compression, therefore, is a measure of all losses and offers a means of comparing different machines on a like basis. As an example, take the air and steam cards of a commercial two-stage compound compressor, shown in Figures 1 and 2.

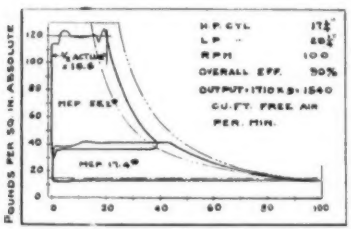


FIG. 1. COMBINED AIR DIAGRAM OF TWO-STAGE COMPRESSOR.

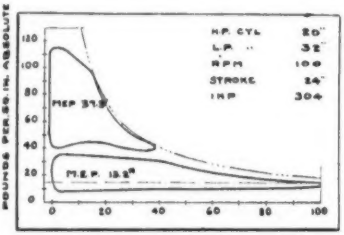


FIG. 2. COMBINED INDICATOR DIAGRAM OF STEAM CYLINDER OF AIR COMPRESSOR.

Calling p_1v_1 and T_1, the pressure, volume and temperature at entrance to compressor, and p_2v_2 and T_2 the same items respectively at discharge of compressor, we can determine any one quantity when the remaining ones are known from the well-known thermo-dynamic equation

$$\frac{p_1v_1}{p_2v_2} = \frac{T_1}{T_2}$$

From observations taken in connection with card in Figure 1 we know that

$p_1 =$ 14 lbs. per sq. in. absolute
$v_1 =$ 100 volumes.
$T_1 =$ 501 deg. F. absolute.
$p_2 =$ 120 lbs. per sq. in. absolute.
$T_2 =$ 790 deg. F. absolute.

Substituting these values in the above equation we find

$$v_2 \text{ (calculated)} = \frac{T_2p_1v_1}{p_2T_1} = \frac{790 \cdot 14 \cdot 100}{120 \cdot 501} = 18.5$$

From the card in Figure 1 we find that v_2 (actual) = 16.6; therefore, the volumetric efficiency becomes

$$Ev = \frac{v_2 \text{ (actual)}}{v_2 \text{ (calculated)}} = 90 \text{ per cent.}$$

This efficiency shows that not all the air taken in on the suction stroke of the first stage is compressed to the final pressure, but that part of it disappears in leaks through stuffing boxes, packing rings, valves, inter-coolers, etc. The displacement of the first-stage cylinder of this particular machine is 1,710 cubic feet per minute at 100 revolutions per minute, and is the free-air capacity of the machine at 100 per cent volumetric efficiency. The output under actual conditions, on the other hand, is $1{,}710 \times .90 = 1{,}540$ cubic feet free-air compressed to 100 pounds gauge.

Figure 3 shows the work of compressing one cubic foot of free standard air, and it will be seen that to compress to 100 pounds gauge isothermally requires 4,350 foot-pounds. Had, therefore, the 1,540 cubic feet per minute been compresed isothermally

$$\frac{4350 \cdot 1540}{33000} = 197.5 \text{ h. p.}$$

would represent the energy expended upon the air.

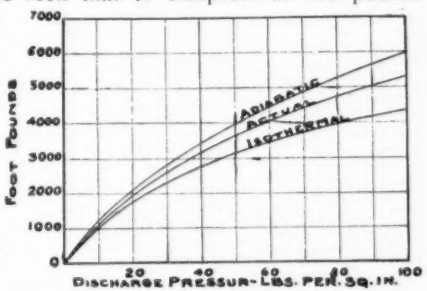


FIG. 3. CURVES SHOWING WORK OF COMPRESSING ONE CUBIC FOOT OF FREE AIR.

The steam cards taken simultaneously and shown in Figure 2 give us 304 indicated horse power in the steam cylinders. The efficiency referred to isothermal, therefore, becomes

$$\frac{197.5}{304} = 65 \text{ per cent}$$

and can be defined as follows:—

Efficiency of a compressor referred to isothermal is the ratio of the theoretically minimum work required to compress the mass of gas actually delivered, to the work actually expended in compressing it.

Some Test Results.

Table I shows the condensed data and results of tests made on six commercial compressors, which have been in uninterrupted service for a number of years. The average of these figures can be taken to represent fairly accurately the performance of first-class reciprocating compressors. The steam consumptions given here were estimated by customary methods from the indicator cards, in the absence of means of weighing the condensation.

Table I.—Test Results of Six Piston Compressors.

Comp. No.	Q_r	H. P. in Steam Cyl.	$Q_r . W$ / 33000	E_r	W (Condensing)
1	1520	302	200	66.5	3.58
2	1430	294	187	64.2	3.95
3	1510	294	198	67.5	3.71
4	1470	312	194	64.0	3.80
5	1435	291	189	65.0	3.81
6	1510	303	199	65.7	3.56

Table II.—Test Results of a Low-Pressure Turbo-Compressor.

	Test No. 1	Test No. 2
Steam Turbine.		
R. P. M.	3632	3663.5
Avg. Steam Pres. lb. per sq. in. absolute	16.57	17.64
Vacuum referred to 30-in. barometer	28.20	28.27
Hot well temperature deg. F	88.21	90.00
Steam consumption lb. per hr	18960	19331
Turbo-Compressor.		
Temp. of air in suction pipe deg. F	35.25	35.78
Barometer — in. of mercury	30.17	30.17
Free air quantity discharged cu. ft. per min	3742	4373
Free air quantity discharged cu. ft. per min. referred to 30-in. bar. and 60 deg. F	3926	4585
Discharge pres. lb. per sq. in gauge	78.35	79.38
Discharge temp. deg. F	182	192
Cooling Water—lb. per hr	18453	23700
Efficiency.		
Lb. steam per hr. per cu. ft. standard free air per min	4.70	4.216

In a paper read before the German Blast-Furnace Society by C. Regenbogen, and translated and abbreviated in the June, 1909, issue of the *Iron Age*, the author gives performances of turbo-compressors on the testing floor of the factory. In conducting the efficiency tests of these turbo-compressors accurate means were adopted to determine the actual volume displaced by these machines. The steam consumption was determined in the customary way by weighing the condensation from surface condensers. Figure 4 shows charac-

teristic pressure-volume and efficiency curves of a turbo-compressor built for a pressure of 70 pounds gauge.

In the October 27 issue of *Stahl und Eisen* appears an article describing a test of a turbo-compressor on the premises of the purchaser conducted by Prof. Stach. Table II shows the data and results of this test translated into English units. Unfortunately, Prof. Stach does not give the efficiency referred to isothermal. He states in the text of his article that the machines developed practically the same efficiency on the premises of the purchaser, after a period of six months' operation, that they showed at the works of the manufacturer.

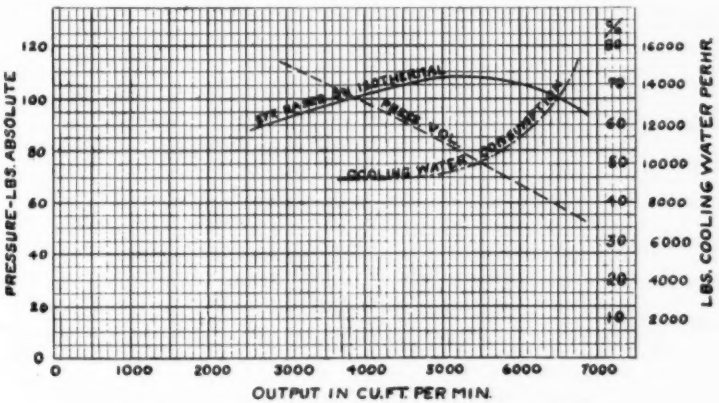


FIG. 4. CHARACTERISTIC CURVES OF TURBO-COMPRESSORS.

The reliability of turbo-compressors as machines suitable for responsible work is illustrated by the fact that the first machine, designed by Prof. Rateau and built in the shops of Sautter and Harlé in Paris, has been in uninterrupted service since 1906. This machine was built in four stages, with inter-coolers between them, and consisted of two separate machines, each having a low-pressure turbine and two-stages of the compressor on its shaft. In addition, one side of the machine was equipped with a high-pressure turbine, so arranged that in the absence of low-pressure steam it could take high-pressure steam and expand it through the low-pressure turbine on the adjoining shaft. This machine delivers 3,180 cubic feet of free air per minute at a discharge pressure of 105 pounds gauge, when running at 5,000 revolutions per minute. Subsequent installations of rotating air compressors for both blast-furnace and Bessemer work have corroborated the first findings, and from the number of repre-

sentative European firms manufacturing rotary compressors of different types, and the continually growing list of installations, it would seem that they have gained the confidence of both manufacturer and user. With respect to the advantages of high-speed rotating machines over reciprocating compressors, the same arguments hold that led to the replacement of engine-driven generators by turbine-driven ones. The development of compressors for high-pressure work became possible with the advent of high-speed steam turbines and electric motors, with the attending high peripheral velocities on small diameters. All troubles that first had to be overcome in high-speed machines have long ago disappeared, and the rotary compressor entered the field with the experience of the past in its favor.

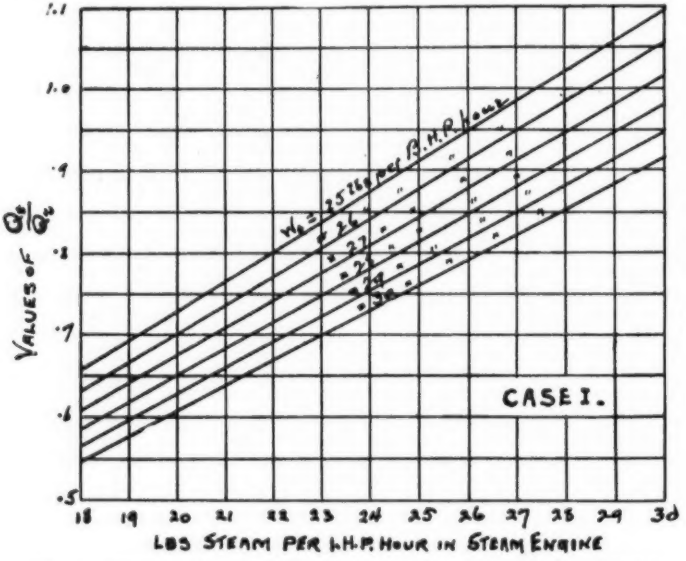

1.1
1.0
.9
.8
.7
.6
.5
VALUES OF G'/G
W = 25.26 lbs per B.H.P. hour
" 26 " " " "
" 27 " " " "
" 28 " " " "
" 29 " " " "
" 30 " " " "
CASE I.
18 19 20 21 22 23 24 25 26 27 28 29 30
LBS STEAM PER I.H.P. HOUR IN STEAM ENGINE

FIG. 5. CURVES SHOWING RATIO OF WORK DONE BY TURBO-COMPRESSORS.

General Calculations Pertaining to Application of Low-Pressure Turbo-Compressors.

In all applications of low-pressure turbines, a very careful study must be made of the available low-pressure steam in order that the low-pressure turbine be correctly proportioned and operate at the point of its highest efficiency. The output in compressed air energy of the turbine, therefore, is a definite quantity depending upon its water rate and that of the reciprocating compressors.

A low-pressure turbo-compressor can be applied to existing machines in two different ways. Firstly (Case I), the low-pressure turbine can be connected to a rotating compressor which delivers air at the same pressure as the reciprocating machine. Secondly (Case II), it can be made to drive a compressor which delivers its air at a comparatively low pressure to the first stage of the reciprocating machine, thereby increasing its output. These two cases will be considered separately.

CASE I.

Calling in the following equations:

Q_r cubic feet of free air compressed per minute by reciprocating machines.
Q_t ditto by turbo-compressor.
w_r and w_t water rates of reciprocating and turbo-compressor respectively.
E_r and E_t efficiency referred to isothermal of reciprocating and turbo-compressor respectively.
W Work of isothermal compression in foot-pounds to any pressure.
f factor representing quality of exhaust from last steam cylinder,

we can write the following equation:—

$$f\frac{W\,Q_r\,w_r}{E_r\,33{,}000}=\frac{W\,Q_t\,w_t}{E_t\,33{,}000}$$

or canceling

$$\frac{Q_t}{Q_r}=f\frac{w_r\,E_t}{w_t\,E_r}\qquad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Equation (1) shows that the pressure to which the air is compressed has no bearing upon the ratio of work done in the two machines.

Calling Q_r unity in above equation

$$Q_t=f\frac{w_r\,E_t}{w_t\,E_r}\qquad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

Equation (2) expresses the output of the turbo-compressor in percentage of the free-air displacement of the reciprocating machine.

The overall steam consumption "w," expressed in pounds of steam per hour per cubic foot of free air compressed per minute, then becomes (since the only steam consumed is that taken by the steam cylinders of the reciprocating engine):—

$$w=\frac{W\,Q_r\,w_r}{E_r\,33{,}000\,(Q_r+Q_t)}$$

or calling Q_r unity

$$w = \frac{W\, w_r}{E_r\, 33{,}000\ (1 + Q_t)} \qquad (3)$$

From equations (1) and (3) curves in Figures 5 and 6 are plotted for a discharge pressure of 100 pounds, using 4,350 foot-pounds for W from curve in Figure 3, .70 and .65 for E_t and E_r respectively, and .85 for f.

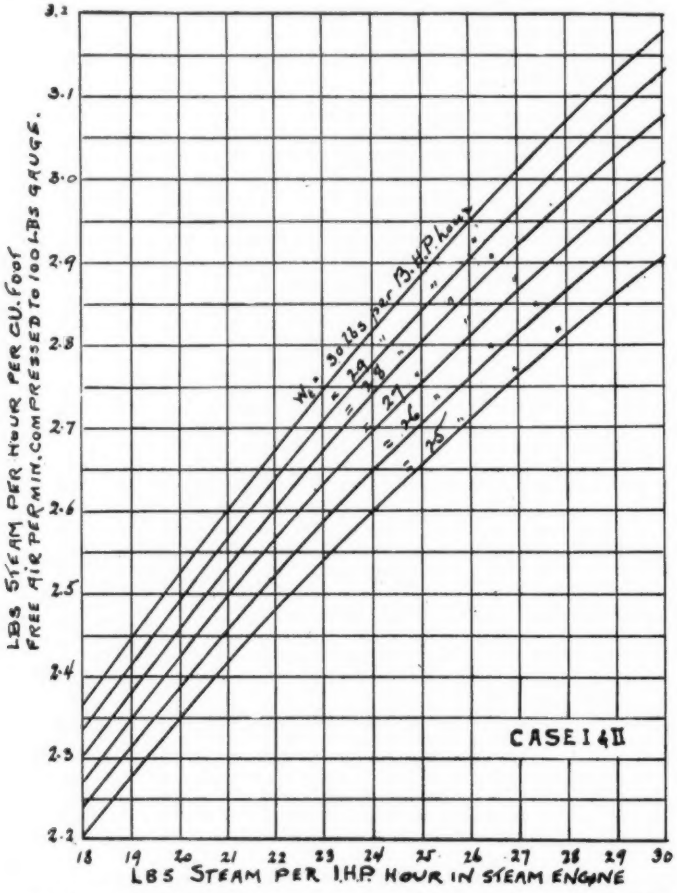

LBS STEAM PER HOUR PER CU. FOOT FREE AIR PER MIN. COMPRESSED TO 100 LBS GAUGE.
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
W = 30 lbs per I.H.P. hour
" = 29 " " " "
" = 28 " " " "
" = 27 " " " "
" = 26 " " " "
" = 25 " " " "
CASE I & II
18 19 20 21 22 23 24 25 26 27 28 29 30
LBS STEAM PER I.H.P. HOUR IN STEAM ENGINE

FIG. 6. CURVES SHOWING OVER-ALL STEAM CONSUMPTION AT DIFFERENT WATER RATES OF COMPONENT MACHINES.

These curves are developed for the purpose of illustrating the relation between over-all and individual water rates and the ratio of work done in the turbo-compressor. Take for a very ordinary case where $w_r = 22$ pounds per indicated horse power (non-condensing) and $w_t = 27$ pounds per brake horse power, the over-all consumption becomes 2.60 pounds steam per hour per cubic foot of free air compressed to 100 pounds gauge, the turbine compressing 0.74 of the quantity discharged by the reciprocating machine. Under these conditions, therefore, it will be seen that the output of a non-condensing compressor can virtually be doubled by the addition of a low-pressure turbine and a high-grade condenser, without increasing the total steam consumption. The factor f appearing in equations (1) and (2) will vary between .85 and .90, depending upon the quality of the steam supplied, the cylinder ratio, and the cut-off.

CASE II.

Instead of compressing air in the turbo-compressor to a like discharge pressure with that of the piston compressors, this case will consider the turbine as the first stage of the air cycle. Calling—

Q total quantity of standard free air compressed per minute
x the foot-pounds of work referred to isothermal expended per cubic foot of free air by the piston compressors
$(W - x)$ then is the work that the turbo-compressors must do per cubic foot of free air where W is the total work of compression referred to isothermal,

and leaving the remaining designations the same, we can write the following equation:—

$$f \frac{Q \times w_r}{E_r \, 33{,}000} = \frac{Q \, (W - x) \, w_t}{33{,}000 \, E_t}$$

or canceling—

$$\frac{f \times w_r}{E_r} = \frac{(W - x) \, w_t}{E_t} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Equation (4) shows that the total quantity of air compressed has no bearing upon the ratio of work done by each machine.

When the discharge pressure is known, W can be determined from the curve in Figure 3 and x calculated by substituting valves for the water rates and efficiencies of the two machines.

Since, again, the only steam used is that supplied to the steam cylinders of the reciprocating machine, the over-all consumption "w" in pounds per hour per cubic foot free air compressed per minute becomes—

$$w = \frac{x \, w_r}{E_r \, 33{,}000} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

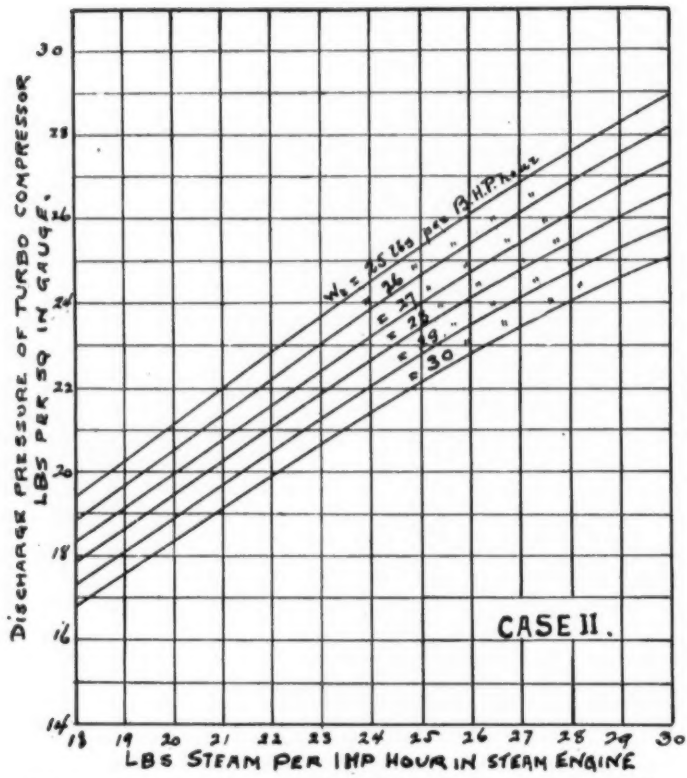

DISCHARGE PRESSURE OF TURBO COMPRESSOR LBS PER SQ IN GAUGE.
30
28
26
24
22
20
18
16
14
W = 25 Lbs per I.H.P. hour
" = 26 " " " " "
" = 27 " " " " "
" = 28 " " " " "
" = 29 " " " " "
" = 30 " " " " "
CASE II.
13 19 20 21 22 23 24 25 26 27 28 29 30
LBS STEAM PER IHP HOUR IN STEAM ENGINE

FIG. 7. CURVES SHOWING DISCHARGE PRESSURE OF TURBO-COMPRESSORS.

From equations (4) and (5) curves in Figures 6 and 7 are plotted for a discharge pressure of 100 pounds, using 4.350 foot-pounds for W, .70 and .65 for E_t and E_r respectively and .85 for f.

From these curves we see that for a similar case to the one taken in the first calculation, namely, when $w_t = 27$ and $w_r = 22$—

$$x = 2485$$
$$(W - x) = 4350 - 2485 = 1865$$

Referring to the curve in Figure 3 we see that the turbine must deliver the air to the piston compressors at 21.8 pounds gauge. The over-all water rate from equation (5) under these conditions is 2.60 pounds steam per hour per cubic foot per minute.

These curves show that in order to maintain a balance between the prime movers of the two machines, the discharge pressure of the

first compression stage must be a definite amount, depending upon the efficiencies and steam consumptions of the component machines. This pressure will vary from 17 to 29 pounds over the range of performances of machines of this type.

When a combination such as the one outlined above is attempted, it must be borne in mind that slight changes to the reciprocating machines must be made, as in all probability the steam cylinders of commercial compressors will not be equal to the task of compressing a much larger volume of free air to the final pressure, though it be delivered with the compression partly done.

Let us call the normal displacement per minute of the low-pressure air piston Q_r. We know that not all the air taken in on the suction stroke is discharged, but that there is a certain amount of slip. Calling the volumetric efficiency E_v and the efficiency referred to isothermal E_r as above, and the normal displacement Q_r, then the normal power of the steam cylinders can be determined as follows:—

$$\text{Normal horse power of steam cylinder} = \frac{Q_r E_v W}{E_r 33{,}000} \quad \ldots\ldots\ldots\ldots (6)$$

Since the parts of the steam end of the compressor are designed to transmit this energy, it would be unwise to attempt to install larger steam cylinders on existing machines; instead, it would be preferable to decrease the size of the air cylinders. As the piston compressors will now be expending x foot-pounds per cubic foot, the volume of free air that they can now pass through them at normal horse power in steam ends can be seen from the following:—

$$\frac{Q_r E_v W}{E_r 33{,}000} = \frac{Q_r E_v x}{E_r 33{,}000} \text{ or } \frac{Q}{Q_r} = \frac{W}{x} \quad \ldots\ldots\ldots\ldots\ldots (7)$$

For the condition given in example above $\frac{Q}{Q_r} = 1.74$ Q_r, or calling Q_r unity, the increase in output due to addition of the low-pressure turbine is .74, or identical with Case I. This, of course, is as it should be, for in these two sets of calculations identical conditions were assumed. This will not be the case in practice, for E_t and E_r will not stay unchanged, regardless of whether the machines are doing complete or partial compression. Since no data are available at this writing, no discrimination was made, but there is reason to believe that a turbo-compressor will exhibit the same slight loss in

efficiency at high pressure that the steam turbine does. Likewise, it is believed that, on the other hand, the piston compressor will show a slightly better performance when receiving air at an initial pressure. It would, therefore, be fair to forecast that an arrangement of machines as described in Case II would yield a better over-all economy, based simply on an improvement of the efficiencies of the component machines. If further we consider that three-stage compression offers a better opportunity for inter-cooling, and that the resultant work expended on the air will more closely approach the isothermal line, there would seem no doubt at all as to preference between the two arrangements from the standpoint of economy. Unfortunately, economy is not in all cases the only factor. We must remember that in adopting the three-stage form, changes have to be made to the air cylinders of the piston compressors, firstly in order to stay within the power limits of the steam cylinders, as shown in equation (7), and secondly to re-adjust the ratio of air cylinders, which for 100 pounds pressure and the conditions of our example should conform approximately to the combined theoretical air diagram shown in Figure 8. This change is not costly, and will be off-set by the lower cost of the low-pressure turbo-compressor over the high-pressure one, but the change is in the direction of making the displacement of the piston compressor smaller and hence decreasing its intrinsic ouput, if put on its own resources, should some derangement require the taking out of service of the turbine. Similarly an accident to the piston compressor would make the turbine, with its low delivery pressure, useless. The reliability of the outfit, therefore, is greatly impaired, unless the installed capacity of the plant as a whole is large enough to afford splitting it into groups, with a certain percentage of equipment in reserve. The selection between these two cases must necessarily be guided by the conditions of each individual installation. These calculations were undertaken for the purpose of bringing out the suitability of low-pressure turbines to compressor work and to illustrate a method for developing the possibilities of each individual case.

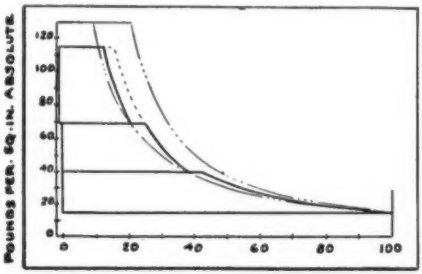


FIG. 8. THEORETICAL AIR DIAGRAM SHOWING THREE-STAGE COMPRESSION.

Conclusion.

Many very valuable articles have been written on the principles and theories that govern low-pressure turbine application. It is generally understood that a very careful study of the existing steam engines to which the turbine is to be applied must be undertaken, with a view to determining the steam consumption with relation to steam distribution in the steam cylinders. This takes one into the study of the most economical receiver and back pressure. I believe though an erroneous opinion exists that the water rate of the engine when coupled to a steam turbine has only a small bearing upon the ultimate economy of the combination, because it is believed that the low-pressure turbine will in all cases compensate for poor economy in the engine. A reference to curve in Figure 6 shows plainly the

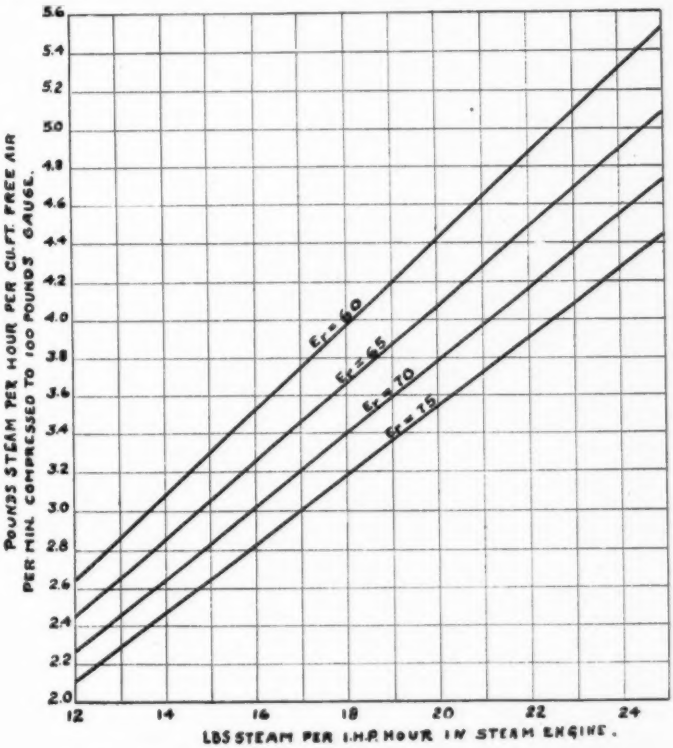


FIG. 9. CURVES SHOWING PERFORMANCE OF PISTON COMPRESSORS.

influence of the water rate of the steam engine upon the over-all performance, and this indicates that as much attention should be paid to adjusting the engine conditions as to proportioning the low-pressure turbine to the available steam at the most suitable initial pressure.

That the addition of low-pressure turbines driving rotating compressors is a judicious policy cannot help but impress itself from the figures and curves presented above. We have seen that the cost in steam ranges from 2.2 to 3.2 pounds per hour per cubic foot of free air per minute compressed to 100 pounds. Curves in Figure 9 show steam consumption per cubic foot of a piston compressor at various water rates and efficiencies. These curves bring out that an economical engine, coupled to an efficient compressor, can deliver air at a steam cost that does not compare unfavorably with the performance of the combination; but when we consider that the addition of a high-grade compressor to an existing plant gives us only a portion of the output economically, while the addition of the turbine adds capacity and improves the economy of the entire output, there would seem to be no doubt in the selection. As stated at the outset of this paper, low-pressure turbines seem inherently adapted to redeem wasteful installations. With the ability to make a turbo-compressor for high pressures and the long established practice in complete-expansion, high-speed steam turbines, there is reason to believe that in the near future we may hope to see modern compressed-air stations consisting entirely of rotating machines, yielding their output at an economy very close to that of the combined plant without the attending complications of the latter.

EDITORIAL COMMENT

The Science of Industry.

SINCE the decline of the classics a strong tendency has appeared among educators (meaning the administrative heads of colleges and universities) toward the magnification of philosophy and psychology, at some detriment to science, especially applied science. "Philosophy" is indeed so broad a term that it might embrace with catholic affection all branches of learning; but in the university-faculty sense it becomes less comprehensive in scope and less charitable in spirit. This disposition is apparent in the apportionment of the university personnel and the funds. It is unconsciously disclosed in academic procedure and precedents. The highest degree conferred in course is Ph. D.—"philosophy" thus often attaching nominally to her temple the devotee who really belongs to science. The technical school is the Cinderella of the family, pushed backward by the sweeping skirts and chilly shoulders of her older sisters—psychology and philosophy.

Yet what student of mental science, if he would deign to examine so extremely unacademic a subject as industrial engineering, could fail to find in Mr. Gantt's charts, which we publish this month, a most interesting and fertile study in experimental psychology? They provide an intimate revelation of human conduct as controlled by emotions, ideals, and purposes—material for a thesis, better worthy of a degree than many which are accepted by university examiners.

Again, what metaphysician could fail to find, in Harrington Emerson's analysis of the elements and principles of efficiency, that "science of effects by their causes"—that "discovery of fundamental matters"—that "coherent body of theorems"—which constitutes philosophy? His resolution of the conduct of industry into four primary concepts—imaginations, principles, methods and devices; his "dependent sequence" of the twelve elements of efficiency—inspiration or ideals; common sense; expert advice; discipline; the fair deal; reliable, immediate and adequate records; definite standard-practice instructions; dispatching; time study; standardized conditions; standardized operations; efficiency rewards*—is there not here the outline of a "science of things evidently deduced from first principles"—in other words, a philosophy?

But alas! The academician still hugs fast a notion from which the aristocrat's hold is partly shaken—the notion that it is a degradation to be "in trade." And it is "in trade," or in industry, that the philosophies of Gantt and Emerson are of inestimable value and promise.

Work on the Isthmus.

AS a headline, the "Original Canal Dug" with which the *Canal Record* introduces its notes of progress in the issue of April 6 is regrettable. It is unfortunate, first, because it is untrue in the sense which will certainly be conveyed to the average reader. The yardage excavated may indeed equal that required by the plans for the "original canal;" but it does not come from within the lines or limits of those plans, and its removal does not accomplish the excavation of a waterway corresponding in position or dimensions to that original canal. There is not, of course, even a distant approach to the completion of any sort of a canal through which vessels can pass. In the

* This complete development of Mr. Emerson's efficiency practice, covering the tests by which the efficiency of established industries is tried and the steps by which betterment of efficiency is introduced, will be set forth in a series of articles by Harrington Emerson beginning in the issue of THE ENGINEERING MAGAZINE for June next.

public imagination, however, this headline (which is being immediately seized and displayed broadcast by the daily press) will inevitably create a very positive impression that there is now substantially complete a waterway which should be as serviceable as the one planned by the minority of the International Board of Engineers, and later adopted by Congress, and that all the time which will elapse from now until the canal is actually opened is required for the enlargement due to the "changes in plan made subsequently by order of the President."

This enlargement is nevertheless enormous. In the notes already quoted, it is explained that by Presidential order the total excavation was raised from less than 104,000,000 to nearly 175,000,000 cubic yards. This is an increase of about 70 per cent in excavation alone; and when the locks, dams, and auxiliary features are considered the increase is much greater yet. It is extraordinary, indeed, that while the original plans could be adopted only after years of investigation, study, and deliberation, departures from these plans multiplying the cost to the country should be made autocratically by Presidential order. Under no Administration except that which ended March 4, 1909, is it likely that such legislation under the guise of administration would have been undertaken.

The Briquetting of Fuel.

AN indication of the activity of interest in matters connected with practical conservation of the fuel supply is afforded by the responsive reception that has been given to Mr. Wright's articles on briquetting. As a partial result, certain additional data concerning the state of the art have reached the author and the Magazine too late for inclusion in the body of the article. Among the single-compression machines mentioned by Mr. Wright on page 202 should be included an American model—the Rutledge machine made for the Rutledge & Taylor Co. of St. Louis, and recently installed at their Livingston, Ill., plant. To the Renfrow and Misner presses, mentioned on page 205 as American examples of double-compression presses, should be added the briquette press of the Coal Briquette Machine Co. of Oshkosh, Wisconsin, and among the roll type presses listed on page 208 should be included the Allen press, designed by Charles R. Allen of Oakland, Cal.

The Charles Frederick Chandler Foundation.

THE establishment of the "Charles Frederick Chandler Foundation" by the Alumni of Columbia University is a noteworthy addition to the great scientific institutions of the world—great, not in the mere financial or numerical sense, but in the sense of associating about an enduring centre the personalities and the work of great minds of many generations. It has been created as a testimonial, by Dr. Chandler's old students and associates during a half-century of active work in the University and in professional life. The fund accumulated by their subscriptions (and for the present kept open to other contributors who may wish to participate) will be administered by the trustees of Columbia University. From its income will be defrayed, each year, the expenses of one or more great University lectures by the most distinguished workers in the field which Dr. Chandler has so long cultivated. To their honorarium will be added the Chandler Gold Medal, a replica of the original which was given to Dr. Chandler on the evening of April second. Thus is inaugurated an American counterpart of the Faraday Lectures; and, like them, it will grow continually in dignity and sentiment, and bring year by year a richer tribute to the lasting honor of the name it perpetuates.

PEAT AS A SOURCE OF CHEMICAL PRODUCTS.

THE APPLICABILITY TO CONDITIONS IN THE UNITED STATES OF PROCESSES FOR THE UTILIZATION OF PEAT SUCCESSFULLY DEVELOPED IN EUROPE.

Charles A. Davis—Economic Geology.

READERS of THE ENGINEERING MAGAZINE will recall that in April of last year Charles A. Davis, peat expert of the United States Geological Survey, contributed to our pages an authoritative and comprehensive paper on the peat resources of the United States. In this article Mr. Davis was especially concerned with the importance of peat deposits as a source of fuel supply, the utilization of which would relieve materially the drain upon the coal resources of the country. In round figures, he estimated that the peat bogs of the United States, excluding Alaska, cover an area of 11,200 square miles, and are capable of producing 13 billion tons of dry fuel, which, in the form of machine peat bricks, would be worth $39,000,000,000. If converted into producer gas by the most recent methods, 619,260 billion cubic feet of gas, with a calorific value of 145 B. th. u. per cubic foot, would be available for power purposes. Coked in the by-product coke oven, the 3,609 million tons of coke produced would be worth at charcoal prices $26,000,000,000, and at coke prices $9,744,000,000, and the combustible gases evolved would have a value as fuel of $6,500,000,000.

The value of the chemical products derivable from peat, however, is much greater than the value of the peat as fuel. In the article referred to above, estimates of the values of the various by-products which could be recovered in coking the peat available in the United States reach the enormous total of $86,000,000,000. Being concerned more particularly with the fuel question, however, Mr. Davis made only passing reference to the importance of peat as a source of chemical products. This subject he has discussed at length in *Economic Geology* for January, and we desire in this review to supplement the information as to processes for the utilization of peat we have already given both in these pages and in leading articles with a brief outline of the most recent developments.

The use of peat as a source of certain kinds of chemical products is no new thing. In Northern Europe, where extensive peat deposits have long been a source of fuel supply, peat was distilled in retorts to secure tar and gas as early as the latter part of the eighteenth century. The general awakening to the importance of chemical industries in the middle of the last century led to the establishment in considerable numbers of enterprises based on the conversion of peat into chemical products, but for various reasons they failed to attain commercial success and soon ceased to be operated. These pioneer plants were designed to produce, by the destructive distillation of peat, six materials: (1) sulphate of ammonia; (2) acetate of lime; (3) pyroxylic spirit (wood or methyl alcohol); (4) naphtha (light) petroleum oils; (5) heavy (illuminating)

oils; and (6) paraffin (mineral wax). The modern chemist would add to this list but two other substances derivable from peat, namely, asphaltum, and creosote oil and its derivatives. To explain the present commercial success of an industry which had to be abandoned half a century ago, however, he can point to a vast extension of the applications of the various substances derived from peat, and, most important of all, to advances in chemical engineering which have made possible the production at a profit, on a large commercial scale, of chemical substances that formerly could be produced only as matters of experiment in the laboratory.

Progress in the utilization of peat as a source of chemical products has progressed along four well defined lines, each of which is now represented in Europe by a process which seems well within the possibility of commercial success. The four processes, all of which have been brought out within the last twenty years, are: (1) the manufacture of peat coke with recovery of the chemical by-products; (2) the manufacture of producer gas from dry peat with recovery of by-products; (3) the manufacture of producer gas from wet peat in the presence of excess of steam under pressure, with the recovery of the ammonia as ammonium sulphate; and (4) the direct manufacture of ammonium sulphate, acetic acid, acetone, and paraffin by burning wet peat in a special furnace, the chemical compounds secured being the only salable products of the whole series of operations.

The first of these processes, the manufacture of coke or charcoal from peat with recovery of chemical by-products, originated in the early days of peat utilization, when peat was charred in heaps or in cylindrical furnaces by the combustion of part of the charge. The history of the development of by-product coking is too well known to require review. Suffice it to say that the first commercial plant for the conversion of peat into coke with recovery of by-products designed along modern lines was erected at Oldenburg, Germany, in 1894, the invention of Dr. Martin Ziegler. A complete description of the Ziegler process was given in these columns in our February, 1908, number. We shall give here only a few recent test results quoted by Mr. Davis. The peat delivered at the kiln costs $1.19 per metric ton (2,204 pounds). On coking it yields, per ton:

	Pounds.	Value.
Peat coke	775.6	$3.75
Tar	88.2	.52
Wood alcohol	13.2	1.00
Calcium acetate	13.2	.17
Ammonium sulphate	8.8	.21
		$5.65

In addition, gas is produced worth as fuel at least 25 per cent. of the value of the coke.

A four-oven plant treats about 100 tons of air-dried peat each 24 hours. From this amount the following quantities of by-products would be obtained:

	Quantity.	Value.
Ammonium sulphate	900 pounds	$27.63
Calcium acetate	1,320 "	31.02
Methyl alcohol	65 gallons	45.50
Light oils	280 "	21.00
Heavy oils	95 "	7.12
Paraffin	715 pounds	26.81
Creosote oil	3,100 "	66.75
Asphalt	440 "	2.20
		$231.03

Deducting 10 per cent. for sale expenses, the actual value of the by-products would be $208. The total expenses per day are estimated at $308.50, so that the 33 tons of peat coke, the primary product, will cost $100.50 or $3.05 per ton. Increase in plant capacity will not entail a corresponding increase in cost of production, and in a plant three times the size of the one considered the sale of the by-products will nearly or quite pay all expenses, leaving the peat coke as practically all profit. The cost of such a plant is large, however. A plant of four ovens requires a first investment, allowing $60,000 for working capital, of $160,000.

We shall omit all but very brief reference to Mr. Davis' discussion of the second and third processes mentioned above. The Mond by-product gas producer is too well known to require comment, and the Frank and Caro modification of the Mond process was described at length in these pages in THE ENGINEERING MAGAZINE for December, 1907. We may quote, however, Mr. Davis' conclusions as to the utilization of peat in by-product producers. These are: (1)

that peat is considered a good source of producer gas for fuel and power uses in Europe; (2) the recovery of by-products, particularly ammonium sulphate, from gas producers using peat as fuel is not only theoretically possible but is commercially so practicable that large plants using the Frank and Caro process are now reported to be in operation or in the course of development in England, Germany and Italy; and (3) that for small peat gas-producer plants for generating electric or other forms of power, the quantity of ammonium sulphate that can be secured even from peat rich in combined nitrogen by the best processes, while technically entirely possible, would probably not prove commercially successful, since the cost of maintaining a small recovery plant is large when compared with the margin of profit.

Passing now to the process invented by Dr. Herman Woltereck, the last of the four mentioned above, the fundamental proposition of the inventor is that the nitrogen that appears in the ammonia he secured is, in part at least, derived directly from the air, so that he practically makes a synthetic ammonia by fixing atmospheric nitrogen. His process is based on the results of a long series of careful laboratory experiments, which showed that when wet peat is burned at a temperature sufficient to keep the fire going in a specially designed furnace, some of the nitrogen of the moist air forced into the combustion zone induced by the oxidation of the carbon unites with the hydrogen of the organic matter that is being decomposed and forms ammonia. No combustible gases are produced, since the temperature of the fuel bed is always kept below the temperature at which water is decomposed by incandescent carbon (550 degrees C.) and at which carbon dioxide is reduced to carbon monoxide (600 degrees C.); the actual temperature maintained is from 400 to 500 degrees C. But tar, tar water and other distillates are produced in abundance, and from these calcium acetate and paraffin are manufactured.

A plant with a capacity of 5,000 tons of ammonium sulphate per year has been in operation for some months at Carnlough, County Antrim, Ireland. The wet peat is charged into furnaces where it is subjected to moist combustion by means of a blast of air charged with steam. The resulting gases contain paraffin tars, acetic acid and ammonia. The tar is recovered in a bath of heavy petroleum oil heated to 300 degrees C., the acetic acid is recovered as acetate of soda or lime in alkali towers, and the ammonia combines with hot dilute sulphuric acid in acid towers to form sulphate of ammonia, the chief product of the process. The paraffin tar drawn from the scrubber is distilled to drive off the lighter oils; the crude paraffin wax remaining is worth $25 per ton without further purification. The sodium or calcium acetate may be further treated to produce acetic acid or acetone. Woltereck states that the average yield of ammonium sulphate in his experimental plant was 150 pounds per short ton of peat and that yields of 278 pounds have been obtained. His claims for the process are: (1) it gives a much larger recovery of ammonium sulphate than Frank and Caro's process; (2) it permits the use of peat with from 75 to 80 per cent. of water, which is practically as it is dug; (3) it is independent of all other industries, so that the plant can be operated on its own merits, and not on the basis of other and entirely foreign business, as is the case with by-products plants which must be closed when the power plant is not operated; and (4) acetic acid and paraffin enough can be recovered to meet all expenses of digging the peat and burning it, so that the ammonium sulphate worth about $60 per ton will be practically all profit.

What is the possibility of employing any or all of these processes for the utilization of the peat deposits of the United States? Mr. Davis points out early in his paper that with very few minor exceptions there is no overlapping of the areas of occurrence of workable peat and the coal fields of the country; if no other use is made of the peat, there is stored up in it a large amount of fuel in parts of the country where it is needed. Mr. Davis believes, however, that all the processes involving the recovery of chemical products "have commercial

possibilities in the United States, if enough capital is available for the construction and maintenance of a plant through the stage of development. Where a market can be had, or is waiting, for peat coke, as in the iron-bearing regions of Michigan, Wisconsin and Minnesota, this should be the primary product, with by-product recovery so far as markets could be found for the material that could be made from the condensible gases. When power can be readily disposed of, producer gas for the generation of electricity is clearly indicated as a means of most successfully using peat deposits, and if the power plant is a large one, by-products recovery will reduce the operating expenses if the heat balance is carefully watched and a proper type of gas producer used, so that the largest possible amount of the valuable ammonia is recovered, as it seems demonstrated that this recovery may be carried on profitably in properly designed large installations. . . . . Finally, it is desirable to have some of the commercially promising processes of chemical manufacture tried under American conditions, so that it may be demonstrated that it is as profitable to use them in the United States as in Europe."

FATAL ACCIDENTS IN AMERICAN METAL MINES.

STATISTICS OF THE FATALITIES IN METAL MINING IN THE UNITED STATES AND CANADA AND A DISCUSSION OF THE NEED OF EFFICIENT LEGISLATION.

Frederick L. Hoffman—Engineering and Mining Journal.

FROM the best data available, Frederick L. Hoffman, statistician of the Prudential Insurance Company, has compiled statistics which disclose the startling fact that the death rate due to accidents in metal mining in the United States and Canada is fully as great as the death rate due to accidents among coal miners. That this unenviable record has not been made apparent before is attributed by Mr. Hoffman, in an article contributed to the *Engineering and Mining Journal* for March 5, to the laxity of the regulations in the majority of the metal-mining States. "Information regarding the occurrence of fatal accidents," he says, "is very limited and of more or less doubtful value. Official returns are available for only a few of the more important metal-mining States. No returns are available for the metal mines of California, Nevada, Utah, Arizona, and a number of other States in which the industry is of sufficient importance to warrant official supervision of mining operations and the official publication of the essential facts regarding the industry." The lack of public interest in mining accidents in these States is severely criticized by Mr. Hoffman, who acknowledges the impossibility, under the circumstances, of compiling an accurate summary of mining fatalities for recent years. He believes, however, that the total of 3,871 accidents reported in the United States and Canada since 1894 considerably understates the actual facts. In all probability not less than 5,000 deaths have occurred during the period 1894-1908.

Mr. Hoffman gives a table showing the ratio of persons killed per 1,000 employed in the metalliferous mines of North America during this period. We quote at length from his analysis of the record. "The table shows that between 1894 and 1908 the fatality rate in the United States have varied from 4.79 per thousand in 1895 to 2.37 per thousand in 1908. The rate was as high as 8.28 per thousand in metal mining in Montana in 1896, 7.79 per thousand in iron mining in Dickinson county, Mich., in 1901, and 6.35 per thousand in copper mining in Houghton County, Mich., in 1895; while the rate was as low as 1.45 per thousand for the metal mines of Montana in 1908. The information at present available is not sufficient for a precise differentiation of the accident liability according to the predominating metallic products of the different States. When the returns are combined for the different mining fields and assumed to represent the predominating branch of

the mining industry, it would appear that the fatality rate in gold and silver mining as determined by the combined returns for Colorado, Idaho and South Dakota was 2.75 per thousand for the period considered, while the corresponding rate for lead and zinc mining in Missouri was 3 per thousand; for copper mining in Montana, 3.53; for copper mining in Houghton County, Mich., 2.94; and for the iron mines of the same State 4.17 per thousand. Averaging the data for all the States, and for all the years for which the information is available, the fatality rate in metal mining in the United States has been 3.09 per thousand, which compares with 3.13 per thousand for the coal mines of North America during about the corresponding period of time.

"The average fatality rate for the metal mines of Canada during the same period was 3.78 per thousand. The average rate has been as high as 6.64 per thousand for the silver and cobalt mines of Ontario, and as high as 6.54 per thousand for the gold mines of that province. The average rate was lowest for the iron-ore mines of Ontario, or 1.44 per thousand, and as high as 3.57 for the copper and nickel mines of Ontario, and 3.50 per thousand for the copper mines of Newfoundland. The rate has been comparatively low for the iron and pyrites mines of Newfoundland, or 1.93 per thousand, and, while it has been above the average, or 4.23 per thousand, for the metal mines of British Columbia. Some of the extremely high rates for individual years, and particular mining fields, are due to the small number of men employed and do not indicate with accuracy the true occupation hazard of the industry. The information, however, apparently would seem to be sufficiently complete to warrant the conclusion that the average fatality rate in American metal mines, or 3.09 per thousand, is less by as much as 0.69 per thousand, than the corresponding rate for the metal mines of Canada, which is conservatively calculated at 3.78 per thousand.

"It is made apparent by the preceding analysis that the fatal accident liability in metal mining is certainly not much less than the corresponding accident liability in coal mining. It is quite probable that if the subject were thoroughly inquired into, and if all doubtful data were eliminated, it would be shown that the fatal accident liability is really greater in metal mining than the corresponding liability in coal mining. In this connection it has been pointed out by E. T. Corkill, Ontario inspector of mines, that: 'In metalliferous mining an accident seldom occurs in which a considerable number of men are killed, the fatalities usually being one or two at a time, though in the course of a year they may amount to a large total. Public opinion is, therefore, not aroused; the management of the mine is not so much impressed with the importance of careful supervision; the miners are awakened for a few days, and then forget, and the same conditions prevail as before. It is a common belief among most metal miners that the fatalities in coal mines far exceed those in metalliferous mines. This is a great mistake, and, while it is not proposed to argue that metal mining is as hazardous a calling as coal mining, still the writer desires to impress upon all metal miners that only care and close supervision of their work will lessen the number of accidents and place metal mining on the list of the less hazardous occupations.'"

Mr. Hoffman offers for comparison statistics of the fatal-accident rate in the important mining districts of Europe, Asia, Africa and Australia. The rate of the United States is exceeded only by that of the Austrian mines other than iron-ore (3.11 per thousand), the rate for native miners in the Kimberly diamond fields (3.60 per thousand), the rate in the South African Republic (4.56 per thousand), and the rate in the Transvaal gold mines (4.15 per thousand for white, and 4.74 for native, labor). The rate in France is 2.02, in Germany, 1.07; in Italy, 1.73; in the United Kingdom, 1.14; in Tasmania, 1.19; in West Australia, 2.15, in the Queensland gold fields, 1.70, and in the New Zealand gold fields, 1.53 in alluvial workings and 1.32 in quartz workings.

"It requires no further discussion," Mr. Hoffman concludes, "to emphasize

the practical importance of a qualified inquiry into the whole subject of fatal accidents in metal mining corresponding to the amount of public attention which is being given to the occurrence of fatalities in coal-mining operations. The same neglect of metalliferous mines is characteristic of English mining legislation, which has never been so effective in the case of metal mines as in that of coal mines. There can be no question of doubt but that a qualified inquiry would bring to light many facts of great practical importance, and there can be no excuse for the derelict mining States of the far West, which at present give no official publicity whatever to the facts of accident occurrence, fatal or otherwise, in the metal mines of the respective States."

THE PROGRESS OF THE ELECTRIC STEEL FURNACE.

RECENT ADDITIONS TO THE LIST OF ELECTRIC STEEL FURNACES THROUGHOUT THE WORLD.

Stahl und Eisen.

IN January of last year we reprinted in these columns from *Stahl und Eisen* a list of electric steel furnace installations in use or under construction in all parts of the world. A new compilation is published in *Stahl und Eisen* for March 23, and in the table below we give a supplementary list, comprising additional installations completed or projected during the last eighteen months. We have included also notes on the more important alterations which should be made in the record as published early last year.

A comparison of the two lists shows some interesting indications of the general tendencies in the development of the electric steel furnace. In the table published last year 78 furnaces were listed, 35 of the induction, and 43 of the

RECENT ADDITIONS TO THE LIST OF ELECTRIC STEEL FURNACE INSTALLATIONS IN USE OR UNDER CONSTRUCTION IN ALL PARTS OF THE WORLD.

ARC FURNACES.

	Firm.	Capacity, kilograms.	Héroult. Current.	Power requirements, kilowatts.	Remarks.
1.	Gewerkschaft "Deutscher Kaiser", Bruckhausen, Germany	6,000*	Single-phase	800	Charged with cold and molten open-hearth metal. Produces drawn tubes, rails, etc.
2.	Ditto	6,000*	"	800	
3.	Kärntnerische Eisen- und Stahlwerks-Ges., Ferlach, Austria	5,000	"	765	Charged cold. Produces rolled wire.
4.	Brüder Lapp, Rottenmann, Austria	6,000	"	785	Charged cold. Product, dynamo stampings, fine sheets, castings.
5.	Usines Métallurgiques du Hainaut, Couillet, Belgium	5,000*	"	400	Charge, open-hearth metal. Product, castings.
6.	John Allen & Co., Sheffield	2,500*	"	400	Charge, open-hearth metal. Product, tool steel.
7.	Vickers, Sons & Maxim, Sheffield.	2,500*	"	...	.....
8.	Obouchowsche Stahlwerke, St. Petersburg	3,500	"	660	Charge, open-hearth metal. Product for shipbuilding.
9.	Firth-Sterling Steel Co., McKeesport, Pa.	2,500	"	...	Charge, molten open-hearth metal. Product, tool steel.
10.	Ditto	5,000*	"	...	.....
11.	Illinois Steel Co., South Chicago, Ill.	15,000	Three-phase	2,000	Charge, Bessemer metal. Product, railway material.
12.	American Steel & Wire Co., Worcester, Mass.	15,000*	"	2,000	Charge, Bessemer metal. Product, rolled wire.
13.	Electro Metals, Ltd., Welland, Ontario	500	.....	...	.....
14.	Ditto	5,000*	.....	...	.....
15.	Cia. Mexicana de Acero y Productos Chimicos, Mexico	4,000*	.....	...	.....
16.	Ditto	4,000*	.....	...[1]	.....

Two furnaces, aggregating 10,000 kilograms capacity, reported in the former list as under construction for Georg Fischer, Schaffhausen, Switzerland, are not mentioned in the latter compilation. The equipment of the Firth-Sterling Steel Co. is given in the former list as one furnace of 10,000 kilograms capacity, under construction.

* Under construction.

GIROD.

	Firm.	Capacity, kilograms.	Current.	Power requirements, kilowatts.	Remarks.
1.	Cie. des Forges et Aciéries Electriques, Paul Girod, Ugine, France	2,000 to 3,000	Single-phase	300 to 400	Charged cold. Product, ordinary and special steels and castings.
2.	Gutehoffnungshütte, Oberhausen, Germany	2,000* to 3,000	"	300 to 400	Cold and molten charge. Product, high-quality steel.
3.	Stahlwerk Becker, Krefeld	2,000* to 3,000	"	300 to 400	Ditto.
4.	Fried. Krupp A.-G., Essen-Ruhr, Germany	10,000* to 12,500	"	...	Ditto.
5.	Diosgyörer Kgl. Eisen- und Stahlwerke, Diosgyör, Hungary	2,000*	"	300	Charged cold. Product, high-quality steel.
6.	An unnamed American works	500*	"	...	Tool steel.

STASSANO.

1.	Leopold Gasser, St. Pölten bei Wien, Austria	1,000	Three-phase	200	Charged cold. Product, steel castings, high-quality steel.
2.	Ditto	1,000*	"	200	

None of the seven furnaces of the Forni Termoellettrici Stassano, Turin, Italy, is working, the company being in financial difficulties.

KELLER.

1.	Aciéries J. Holtzer, Unieux, France	1,500*	Single-phase	200	Cold and molten charge of open-hearth metal. High-quality and tool steels.
2.	Société des Etablissements Keller-Leleux, Livet, France	1,500	"	200	Charged cold. High-quality and special steels and castings.
3.	Ditto	3,500	"	450	Ditto.
4.	Ditto	200	"	80	Experimental furnace.
5.	Luxemburger Bergwerks- und Saarbrücker Eisenhütten A.-G., Saarbrucken	3,500*	"	450	Molten charge from the basic Bessemer converter. Medium-quality rails and structural steel.

The capacity of the first furnace installed at the Aciéries J. Holtzer, Unieux, France, is given in the later compilation as 8,000 kilograms.

CHAPLET.

1.	Société des Hauts-Fourneaux et Forges, Allevard, France	5,000	Single-phase	600	Charged cold. Product, ordinary and special steels.
2.	Ditto	5,000	"	600	Ditto.
3.	Ditto	5,000*	"	600	Ditto.

AKTIEBOLAGET ELEKTROMETALL, LUDVIKA, SWEDEN.

1.	A. S. Norsk Elektrometall, Norway	6,000*	Two-phase	736	Molten charge from the electric shaft furnace.

Furnaces of this type are in operation or in course of construction for the production of pig iron as follows: one 400-kilowatt, three-phase furnace with a yearly capacity of 2,500 tons at Domnarfvet, Sweden; two 1,850-kilowatt furnaces with a yearly capacity of 7,500 tons each at the A. S. Norsk Elektrometall, Norway; and one 7,500-ton furnace at Trollhättan, Sweden.

FURNACES DEVELOPED BY INDIVIDUAL FIRMS.

1.	A. Hickmann, Staffordshire, England	300	.....	...	.....
2.	Soc. An des Aciéries et Forges, Firminy, France	50	.....	...	Experimental furnace.
3.	Scott Anderson, Sheffield, England	750	.....	...	.....

INDUCTION FURNACES.

KJELLIN.

1.	Vickers, Sons & Maxim, Sheffield, England	1,500†	Single-phase	230	Charged cold. Product, high-quality steel.
2.	Ditto	180†	"	100	Ditto.
3.	Wm. Jessop & Sons, Sheffield, England	1,800*	"	250	Ditto.
4.	General Electric Company, Schenectady, N. Y.	60	"	50	.....
5.	Irvington Smelting & Refining Co., Irvington, N. J.	100	"	60	.....
6.	Electro Metals, Ltd., Welland, Ontario	750	"	150	Charged cold. Product, tool steel.

The following furnaces of this type have disappeared from the list: one 8,500-kilogram furnace at the Röchlingsche Eisen- und Stahlwerke, Völklingen; one at the Allg. Kalziumkarbid-Genossenschaft, Gurtnellen, Switzerland; a 550-kilogram furnace at the works of Vickers, Sons & Maxim; and a 100-kilogram experimental furnace of the Gröndal-Kjellin Co., London.

* Under construction.
† Not in use.

RÖCHLING-RODENHAUSER.

	Firm.	Capacity, kilograms.	Power requirements, Current.	kilowatts.	Remarks.
1.	Röchlingsche Eisen und Stahlwerke, Völklingen	2,000*	Three-phase	275	Molten charge from basic Bessemer converter. High-quality material, rails, etc.
2.	Ditto	2,000*	"	275	
3.	Pilger & Neidhardt, Frankfurt a. M	2,000*	Single-phase	275	Charged cold. Produces steel castings.
4.	Le Gallais, Metz & Co., Dommeldingen, Germany	3,500*	"	380	Charged with molten pig iron from a mixer. Produces high-quality steel and castings.
5.	Aciéries de la Marine et d'Homécourt, St. Chamond, France	3,000*	Three-phase	350	Cold or molten charge. Product, high-quality steel.
6.	Kronwerke Zlatooust, Russia	1,000*	"	175	Charged cold. Product, war material.
7.	Ricardo Honey, Mexico	2,500*	"	300	Charged with molten pig and ore. Product, high-quality steel.

Two furnaces of this type have disappeared from the list: one 3,500-kilogram furnace at the Röchlingsche Eisen- und Stahlwerke, Germany; and a 1,000-kilogram furnace at the works of J. Knöpfel, Walzenhausen, Switzerland.

COLBY.

The single representative of this type has disappeared from the list.

FRICK.

Two furnaces of this type, aggregating 4,800 kilograms capacity, have disappeared from the list.

SCHNEIDER-GIN.

No longer used.

HIORTH.

No longer used.

FURNACES DEVELOPED BY INDIVIDUAL FIRMS.

1.	Forges de St. Jacques, Montluçon, France	...	.....	...	.....

COMBINED ARC AND RESISTANCE FURNACES.

NATHUSIUS.

1.	Oberschlesische Eisenbahn-Bedarfs A.-G., Friedenshütte, Germany	5,000	Three-phase	750	Charge, molten Bessemer or open-hearth metal. For soft and hard steels.
2.	Ditto	1,000	"	250	Charge, solid or molten basic open-hearth metal. For experimental work.

* Under construction.

arc, type, with a total capacity of about 210,000 kilograms. The present compilation lists 114 furnaces, an increase in number of about 46 per cent., with a total capacity of about 356,000 kilograms, an increase in capacity of over 66 per cent. The greater percentage increase in capacity than in number results from the increase in capacity of the individual units, which is noticeable throughout the list.

The number of induction furnaces listed remains the same as before, notwithstanding the development of the Röchling-Rodenhauser furnace. The total capacity of the induction furnaces, however, has decreased from 85,000 to 77,000 kilograms. On the other hand, the total capacity of the arc furnaces, 77 of which are listed in the present compilation, has increased from 125,000 to 273,000 kilograms. A new type of furnace, the combined arc and resistance type, is represented in the present list by two units, with a combined capacity of 6,000 kilograms.

Type.	In operation.	Not working.	Under construction.	Total.
Chaplet	4	..	1	5
A. G. Elektrometall	2	..	2	4
Soc. An. in Firminy	1	..	..	1
Frick	1	..	..	1
Kjellin	10	2	2	14
Kjellin-Colby	2	..	..	2
Röchling-Rodenhauser	6	1	8	15
Girod	9	..	8	17
Héroult	17	..	12	29
Hickmann	1	..	..	1
Hiorth	..	1	..	1
Keller	4	..	2	6
Forges et Aciéries in Montluçon	1	..	..	1
Nathusius	2	..	..	2
Schneider	1	..	..	1
Scott Anderson	1	..	..	1
Stassano	5	7	1	13
Totals	67	11	36	114

In the table above is summarized the information given regarding the number of units of each type of furnace in operation, idle, and building.

POWER DEVELOPMENT ON THE LOS ANGELES AQUEDUCT.

A PRELIMINARY REPORT ON THE POWER AVAILABLE, THE COST OF DEVELOPMENT AND THE PRACTICABILITY OF THE SCHEME.

Engineering News.

ELECTRIC-power development has always been one of the most attractive financial features of the Los Angeles aqueduct project, a description of which was contributed by Burt A. Heinly to THE ENGINEERING MAGAZINE for November, 1909. The bond issue of $23,000,000 in June, 1907, unfortunately exhausted the bonding power of the city without providing funds more than sufficient for the construction of the water-supply aqueduct alone. The finances of the city now make it possible, however, to issue more bonds. Approximately $400,000 can be saved in aqueduct construction through San Francisquito Canyon if power development is undertaken at the same time, and this consideration, coupled with the desire of the city to have the project on a paying basis as soon as possible, is responsible for a by-law authorizing an additional bond issue of $3,500,000 which will have been submitted to the people of Los Angeles before this review appears. At the time of writing there seems to be practically no opposition to the issue of the bonds, and it is now expected that one or more of the power houses will be in operation upon the completion of the aqueduct in December, 1912.

In December last three prominent electrical engineers were constituted a Board to make a preliminary investigation of the power output of the aqueduct. Before summarizing the findings of this Board, after their report to the Los Angeles Water Board, reprinted in full in *Engineering News* for March 24, we may refer briefly to the estimates of the first Board of Consulting Engineers who reported late in 1906. They found three localities along the line of the aqueduct where a surplus fall could be utilized for the generation of power. The most important of these was near Elizabeth Lake, about 45 miles from Los Angeles, where they found a fall of nearly 1,500 feet. It was recommended that this fall be developed by two stations working under heads of 1,060 and 415 feet respectively. A third site was found not far below the end of the aqueduct in the San Fernando valley, where a head of 215 feet could be secured, and the fourth was located near Little Lake, about 150 miles from Los Angeles, where a net fall of 270 feet could be made available. The first Board estimated the maximum power output at 93,000 horse power, to accommodate a load factor on the Los Angeles substation of 40 per cent.

The later Board find seven power sites along the line of the aqueduct and its feeders. These are enumerated in the following table:

Location.	Distance from Los Angeles, miles.	Continuous capacity, kilowatts.
Fernando	24	7,250
San Francisquito, No. 2	40	32,000*
San Francisquito, No. 1	47	51,750*
Haiwee	162	4,500
Cottonwood, No. 1....	185	1,500
Cottonwood, No. 2....	185	2,500
Division Creek.....	225	600

* Peak capacity.

The Board report that "the general plan of the development of electric power along the line of the aqueduct and its transmission to Los Angeles and vicinity is a thoroughly practicable scheme, involving no engineering problems which should not permit of successful solution, and promising a reliable source of power which should find a ready market at prices advantageous to the city. . . . The total amount of power which can be delivered in the vicinity of Los Angeles and ready for sale at step-down voltage is approximately 1,152,000 kilowatt-hours per day, corresponding to a uniform delivery of 48,000 kilowatts or 64,000 horse power for 24 hours, or to a maximum delivery of 90,000 kilowatts or 120,000 horse power on a load curve of form corresponding to the average conditions in and about Los Angeles at the present time and of which the average load is 53 per cent. of the maximum." This

estimate of the power available is approximately 30 per cent. in excess of the estimate of the first Board of Consulting Engineers. The difference is explained by the facts that the later estimate includes 4,500 kilowatts available at Cottonwood and Division Creeks, the development of which was not contemplated by the first Board, and that the final surveys for the location of power sites have shown the possibility of obtaining higher heads than were considered by the first Board without increase of cost of aqueduct construction.

The installation cost for the development and transmission of the power, ready for sale at step-down voltage at Los Angeles, based on a peak-load capacity of 90,000 kilowatts or 120,000 horse power, is estimated by the Board at $80 per kilowatt or $60 per horse power. Many conditions combine to justify this estimate, which is markedly lower than the average cost of hydraulic-power development and installation elsewhere on the Pacific coast and under generally similar physical conditions and surroundings. Among the more important considerations may be mentioned these five: (1) the primary diversion works are a part of the aqueduct project, and the water is carried along the aqueduct line in close proximity to the power site; (2) the principal power sites are relatively close to Los Angeles and are relatively accessible for the transportation and installation of equipment; (3) the power sites offer no severe conditions for engineering construction; (4) sufficient time is available for a complete investigation of the actual conditions at the various sites and for the careful preparation of plans in advance of undertaking the work of construction; and (5) the construction work will profit by the experience gained in like work on the main aqueduct and by the efficient organization developed in the course of its construction.

The plan of development assumes that, under ordinary conditions, "the average aqueduct flow per day will be at the rate of 400 cubic feet per second, and that this flow must be maintained, or at least permitted, whether power is developed or not. With this steady flow the capacity of the power sites at San Fernando and at the Haiwee Dam together with those at the Cottonwood and Division Creek feeders, with average stream flow of 20 second-feet and 8 second-feet, respectively, will provide for a steady development of some 14,000 kilowatts, which is expected to represent, under full development, substantially the minimum demand occurring in the early morning hours. Superimposed upon this uniform output of 14,000 kilowatts, sustained by these steady-flow plants, the amount of power required to accommodate the variable demand throughout the day must vary from nothing to some 76,000 kilowatts. This demand taken in conjunction with the existing heads at the two power sites in San Francisquito Canyon will require a flow of water varying from nothing up to 1,000 second-feet, while at the same time the total amount passed per day must correspond to an average flow of 400 second-feet, as in other parts of the aqueduct. To provide for this variable flow at these sites while at the same time insuring the necessary continuous daily average flow throughout the entire length of the aqueduct, provision is made for adequate storage reservoirs above and below these sites. The function of these reservoirs will therefore be to permit of the regulation of supply in accordance with the demand, while in addition they will have a capacity sufficient to provide a guarantee against interruption of service due to accidents or repairs on the aqueduct line between the Fairmont and Haiwee Reservoirs. These arrangements will effectively provide for the close adjustment of power output to demand, and within the capacities above stated should obviate the necessity of any steam plant for relay or for carrying peak loads."

The total daily energy delivered to the city will be transmitted over the moderate average distance of 65 miles, while the corresponding average distance for the energy at the time of maximum power demand will be 55 miles. An aggregate of 9,200 kilowatts will be generated continuously at points that are 162, 185, and 225 miles from the city. Special facilities for controlling the power factor and regulating the terminal voltage,

such as are usually necessary in transmission over such distances, will not be required. The stations near the city will perform the duty of regulating the distant power sources, with a corresponding increase in reliability, effectiveness and economy. The conditions are favorable for low operating cost. Besides the conditions making for reliability of service already enumerated, the expectation of low operating expense is justified by the lack of need of steam auxiliaries, the reduction in superintendence and labor charges by the development of 70 per cent. of the power in two large blocks of about 46,000 and 30,000 kilowatts respectively, and the relatively close proximity of the main blocks of power to the city of Los Angeles.

The Board recommend a progressive development of the power at such a rate as the growth of the power market may justify. They point out that the demands of the aqueduct project itself will require certain items of installation at the power sites for simply passing the water. To avoid the additional cost of temporary constructions, they recommend as a first step the installation of such portions of the equipment as may be required for this purpose for the aqueduct project itself, together with the full development of one or more power sites as further study may indicate. The proposed bond issue of $3,500,000 they consider well suited to the probable demands of the first step of the power-development programme.

INTERNATIONAL STANDARDIZATION OF ELECTRICAL UNITS.

A BRIEF ACCOUNT OF AN INTERNATIONAL CO-OPERATIVE INVESTIGATION NOW IN PROGRESS AT THE BUREAU OF STANDARDS, WASHINGTON.

Edward B. Rosa—Electrical World.

A GROUP of five physicists, representing the national standardizing institutions of England, Germany, France and the United States, are now engaged, in the laboratories of the Bureau of Standards, in Washington, in an international co-operative investigation on electrical standards. The International Electrical Conference, which met in London in October, 1908, passed certain resolutions with regard to electrical units and standards, but left to an International Committee, comprising representatives of eleven different countries, the duty of completing the specifications for the concrete electrical standards and of deciding upon a new numerical value for the Weston "Normal" cell which could be adopted internationally. The investigation begun in Washington on April 1 last is in discharge of this duty. We take a few data of the scope and methods of the inquiry from an article by Edward B. Rosa in *Electrical World* for April 7.

"As is well known, the value for the Clark standard cell (1.434 volts at 15 degrees C.), which was adopted by the Chicago Electrical Congress in 1893, was not accepted by Germany. After further experimental investigations, Germany adopted the value, 1.4328 volts at 15 degrees C. England, America, France and some other countries have followed the Chicago Congress, whereas other countries have followed Germany, and hence there have been two different values for the volt in use.

"In course of time, the method of preparation of the Clark cell was improved so that the cell became more reliable, but at the same time its electromotive force was slightly altered. At the Bureau of Standards, an allowance was made for the change in the electromotive force of the Clark cell, so as to preserve the unit of electromotive force unaltered. In England, however, the original numerical value was retained in spite of the fact that the new cells had slightly different values from the old. The result was that a discrepancy arose between the values in use in England and America. Hence, there were and still are three different volts in use in different countries. The Weston Normal cell, officially adopted at the London conference in place of the Clark cell, has the following values: In America, 1.0189 at 25 degrees, equivalent to

1.019125 volts at 20 degrees; in Germany, 1.0186 volts at 20 degrees; in England, 1.0184 volts at 20 degrees. Some of the other countries have the same value as America, others the same as Germany. England adopted the last named value only one year ago, and no other country, as far as known, has followed its example.

"The London Conference of 1908 adopted the ohm as represented by the resistance of a specified column of mercury, and the ampere as represented by a certain mass of silver deposited in a silver voltameter, as the two independent fundamental electrical units, and declared that the value of the volt should be derived from these two. The electrochemical equivalent of silver adopted at London was 1.11800 milligrams of silver per second per ampere of current. It was known that different investigators had obtained different values for the electrochemical equivalent of silver, according to the kind of voltameter used and the methods of preparing the silver nitrate, so that the international committee found itself confronted with the problem of preparing specifications for the voltameter, when there was a great difference of opinion as to the proper procedure and as to the true value of the electrochemical equivalent of silver, which had, however, been definitely fixed by the conference. . . .

"It was impossible to select a new value of the Weston Normal cell in terms of the ohm and the ampere until the latter should be more precisely defined than had been done by the London Conference. Correspondence among the members of the committee who were connected with national standardizing institutions seemed to indicate that it would be impossible to agree upon the specifications of the silver voltameter without further investigation, and it was proposed by the American members of the committee that a joint investigation to clear up, as far as possible, outstanding problems on the standard cell and the silver voltameter be arranged with representatives of several of the national standardizing laboratories as participants. Prof. S. W. Stratton, in his capacity as director of the Bureau of Standards, offered the facilities of the Bureau of Standards for an international investigation, and in his capacity as treasurer of the international committee, offered to secure the funds to pay the expenses of the investigation." The work now in progress in Washington is the result of his efforts.

"In addition to the work on standard cells and the silver voltameter, a comparison is to be made of the resistance standards of the several national standardizing institutions. The wire standards of the Reichsanstalt, the National Physical Laboratory and the Bureau of Standards differed only about two parts in a hundred thousand at the last intercomparison about a year ago, the standards of the first two of the above institutions having been fixed independently by legally specified mercury ohms. It is expected that a common value of the international ohm will be agreed upon so that no difference greater than one part in a hundred thousand will exist between the wire standards of the national standardizing institutions.

"It is confidently expected that the committee will succeed in coming to a satisfactory agreement with respect to the official specifications of the silver voltameter and the Weston Normal cell, and will be able to agree upon a value for the latter which can be recommended to all countries of the world for adoption. The degree of accuracy which is now obtainable in electrical measurements, both in absolute measurements and in relative measurements, far surpasses what was possible in 1893, and indeed has increased greatly within the last five years. There is reason to believe that values adopted now will be satisfactory for a generation at least without change. The European delegates have brought with them, from their own laboratories, a quantity of apparatus and chemicals in order that they may reproduce work done in their own laboratories at the Bureau of Standards, as accurately as possible. The Bureau of Standards has provided every facility for carrying on the work expeditiously and with the highest precision." It is hoped that it will be completed within another month.

THE WEIGHT OF SHIPS' CARGOES.

A NEW METHOD OF ASCERTAINING THE WEIGHT OF CARGOES ON BOARD SHIP.

A. Murray—Institution of Naval Architects.

DURING the last few months numerous references have been made in technical journals more exclusively devoted to marine and naval engineering to an invention known as the "Porhydrometer," a device for weighing cargoes on board ship. The invention of an Italian, the device was first installed in an Italian vessel. The results of the first experiments with this full-size installation were so satisfactory that the Italian government became interested and undertook a series of exhaustive tests. The "Porhydrometer" is now recognized by the Italian government as an official weighing machine, and a clause has been embodied in the customs regulations to the effect that the weight of cargo registered by the device shall be accepted as correct by the customs authorities.

We quote at length below from an authoritative description of the "Porhydrometer," communicated by Alexander Murray to the Institution of Naval Architects at the recent annual meeting. "One of the greatest sources of loss to shipowners and shippers," he says, "arises out of the claims for shortages in cargoes, not to mention the inferior weight which is often delivered to vessels taking in bunker coal. Especially in cargoes such as coal, iron ore, grain, etc., which are carried on weight tonnage rates, the losses sometimes are very serious, as even the allowance of 2 per cent. granted in view of weighing a coal cargo often fails to eliminate discontent. The methods of control at present in use are certainly not satisfactory. The taking of draughts and applying the readings to the ordinary displacement scale can hardly be said to be accurate, as it is difficult to measure the draught to within an inch, which may mean an error of about 45 tons, in a 10,000-ton deadweight vessel, and, besides that, there is an error dependent on the varying density of the water in which the vessel is floating. The displacement scale itself is generally calculated from a small-scale drawing, and may also show inaccuracies. With internal draught tubes the errors due to density are not corrected. In most cases the weights declared by the shipper have to be accepted, as the owner, without going to the very great expense of reweighing, is almost powerless, although satisfied in his own mind that he is not being fairly treated.

"After considerable study and experiments, Signor Emilio de Lorenzi, of Genoa, has invented a novel appliance called the 'Porhydrometer,' to overcome these difficulties. The fundamental principles utilised are:—First, that a body floating in a liquid will displace an amount of that liquid equal to its own weight; second, the hydrostatic balance —viz., that the level of liquid in two connected cisterns will be equal if the density or specific gravity is equal, and if the density be different the surface level will vary in exact proportion to the density.

"The method adopted in practice may be described as follows:—Inside the vessel is placed a vertical tube which forms the measuring cistern. This tube is fitted with a water connection, consisting of a small pipe and a valve or sea cock, leading to a point permanently submerged when the vessel is afloat. Thus the water in which the vessel is floating has free access to the vertical tube and rises in it to the same level as outside. Should the water in the tube, through any cause, be of a greater or less density than that in which the vessel is floating, its level will automatically adjust itself higher or lower in proportion to the head measured from the lowest point of the connection.

"The aerometer, which is the chief part of the instrument, is suspended in position inside the vertical tube, and is always partly immersed. The aerometer can probably best be described as a float, although in reality it is made heavier than the water it displaces, and has a varying tendency to sink. As the vessel

is pressed down in the water by cargo, or by any additional weight placed on board, the water rises relatively in the tube and the aerometer is increasingly immersed. The difference of displacement thus caused by the aerometer will reduce its tendency to sink, or the constant downward pull which it exerts. This varying downward pull is measured by an ordinary weighing machine on which the readings are made to correspond to the weight placed on board the ship.

"In some of the earliest instruments designed, the aerometer was made parallel, giving a regularly increasing or diminishing measure of displacement, and the scale on the weighing machine was made to vary as the carrying power of the vessel increased at the deeper draughts. For various reasons this has not been found thoroughly satisfactory, and the weighing machines are now made to standard patterns, with evenly divided scales, which can be easily tested both independently and with the whole apparatus complete, and which fulfil satisfactorily the Board of Trade requirements. The variation of carrying power of the vessel is accounted for in the construction of the aerometer, which, to all intents and purposes, is a theoretical model of the vessel for which it is made. The sectional areas of the aerometer are now made at each and every draught of water to bear exactly the same proportion to the corresponding waterline areas at the same draughts. The form of the aerometer is, therefore, an inverted cone, and its areas, if set up in the form of a curve, will be found very closely to assimilate the curve of tons per inch immersion of the vessel. The areas of the vessel and her aerometer being mechanically fixed, proportionate quantities, and the variations of draught (the multiplier for the displacement cube) being equal and of full natural size in both cases, very great accuracy is attained, and even an exceedingly small alteration in the height of water in the vertical tube will affect the balance of the steelyard. In cases where the correct data for calculating the aerometer are not available, the areas are obtained by simple experiments. A test aerometer of exactly parallel form and known sectional area is inserted, and at various draughts, during the ordinary course of loading the vessel, known weights are placed on board and readings taken on the machine. The correct areas sought for those draughts will then be in proportion to the areas of the test aerometer as the known weights are to the readings. If several such tests are made a curve can easily be set off giving the correct form and size.

"In most cases the weighing machine is fitted with an intermediate lever and counterweight, but the arrangement can be varied to suit the circumstances on board the vessel, and connections made by tension wire or levers. In some smaller installations the aerometer is attached directly to the steelyard; the steelyard in this case must be of the reversed type.

"To overcome errors due to inclination and change of trim, it is necessary to have the measuring part of the apparatus, or aerometer, in the centre of the vessel, both transversely and longitudinally. Transversely this is easily found, and within the ordinary range of inclination no error is perceptible. Longitudinally, however, it is more difficult, as the point sought for is seldom the exact centre of length; what is wanted is the point of intersection of the horizontal normal waterlines with the altered trim waterline. This is approximately the centre of waterline area, and is the point at which the most accurate mean draught can be taken. In cases where the desired position is not available, two tubes opposite and equidistant from that point are fitted and their aerometers united in the manner of a double bogie weighing machine. For excessive changes of trim, such as when the bows are completely out of the water and the overhang of the counter is immersed, the increased waterline area will decrease the depth and cause a difference.

"Further, the steelyard, which by its very nature is a level indicator, must have an adjustment to bring the fixed indicating point to the level position. This is done by placing a spirit level in the base of the machine and hinging the

base around the point of attachment to the rest of the apparatus. It is leveled by a screw.

"The 'Porhydrometer' controls accurately the weights between any light waterline and the full load. It is difficult, if not impossible, especially in large vessels, to establish the exact point at which the ship may be called light, and consequently the machines are generally adjusted to register from a zero somewhat below the probable light draught line; thus a constant tare exists. When weighing either out or in, two readings must always be taken, the difference being the actual load added or removed. The accuracy of a porhydrometer can be tested at any time by placing comparatively small known weights on board the ship."

THE REFORESTATION OF RESERVOIR LANDS.

A SUMMARY OF THE COST OF REFORESTING THE MARGINAL LANDS OF THE WACHUSETT RESERVOIR OF THE BOSTON WATER-SUPPLY SYSTEM.

E. R. B. Allardice—Boston Society of Civil Engineers.

THE marginal lands of the great inland lake known as the Wachusett Reservoir, which was created some years ago for the storage of the water supply of Greater Boston, aggregate 3,380 acres, and in places extend back for half a mile. Early in the development of the water-supply system it was appreciated that if the lands bordering the reservoir were allowed to go to waste, such a condition would be a detriment to the purity of the water supply and a menace to the life of the soil. A small part of the lands were suitable for agricultural purposes, but cultivation and pasturage so close to a source of domestic water supply would create more dangerous conditions than the non-use of the lands. The only course open to the Metropolitan Water Board was to reforest in some way the whole or part of the reservation. The work of reforestation has been in progress for some years, and at the end of 1908 a total area of 1,330 acres had been planted. E. R. B. Allardice has given a comprehensive description of the reforestation in a recent paper before the Boston Society of Civil Engineers, which is printed in the *Journal of the Association of Engineering Societies* for January. We subjoin a few data of the forestry practice and of the cost of the work.

The problem which confronted the Metropolitan Water Board was not one of forestry simply. No precedents existed for the guidance of the Board in making of forestry an important branch of the modern large water supply. While the prospect of financial return was an important consideration, the paramount object in undertaking the reforestation of the reservoir lands was to preserve and increase the purity of the water supply and to protect the margin of the reservoir against damaging floods. The ordinary problems of commercial forestry were complicated by many perplexing conditions arising out of the peculiar relation of the reforestation project to the water supply.

The preliminary investigations showed the reservoir lands to be "made up of small parcels so varied in growth, soil and topography that hardly any two offered the same treatment. The arable lots, pastures and sparsely grown sprout lands offered a splendid opportunity for the practice of modern forestry. The more hardy sprout lands and timber forests could, by the expenditure of comparatively small amounts, be made paying property by cutting out the dead and undesirable trees, thereby giving more light, air and nourishment to the remaining hardy specimens, and assisting nature in the development of a valuable forest. The large areas grown to herbaceous plants, sedges and scrub oaks, of which a large percentage of the reservation was composed, which, therefore, could not be neglected in the solving of the problem, offered an excellent opportunity for experimental features in sylviculture."

The recommendation of the forestry expert employed was "that the entire un-

forested portion of the reservation be planted with native white pines, making a self-perpetuating forest, which would ultimately provide a complete ground cover, requiring no artificial fertilizing or disturbing of the soil, and which would protect the waters of the basin from the direct contamination of manurial matters and soil washed from adjacent farms during heavy freshets or spring floods. The white pine was selected because of its almost universal adaptability to the various kinds of land and growth to be treated, its freedom from leaves, its rising value in the lumber market, and the ease, low cost and certainty of raising it to maturity.

"An outline of the general policy adopted in the reforestation of the marginal lands of the Wachusett Reservoir, comprising as they did 1,090 acres of arable, pasture and light sprout land; 280 acres of thick sprouts and young, thin timber land; and 1,475 acres of heavy timber or forest land, was as follows: first, to establish two forest nurseries, one on each side of the reservoir, for the raising from seed of coniferous trees, mostly native white pines, to form the ultimate or final forest, and of deciduous trees to act as fillers and aid in the final development of the conifers; second, to plant all of the first mentioned class of land with a mixture of white pines and hardwoods; third, to underplant the second class with white pines, making improvement thinnings as the growth of the pines demanded; fourth, to make improvement thinnings in original timber stands, as opportunity permitted; fifth, to clear and maintain a fire guard 40 feet wide around the outside limit of the reservation, to serve as a protection against fires having their origin on abutting land; sixth, to maintain some of the present, and build necessary additional, internal forest roads, 15 feet wide, making accessible all areas, and acting as secondary fire lines, dividing the entire reservation into lots containing from 15 to 30 acres; and seventh, to clear and maintain a 50-foot margin along the forested portion of the flow line of the reservoir and to plant the inside half of it with white pine and arbor vitæ closely spaced, forming an effectual screen or hedge to keep the greater part of the foliage from adjoining forests from being blown into the reservoir."

Early in 1898, about eight years before the completion of the reservoir, work was begun on the first nursery, about 4.3 acres in extent. About two years later a second nursery, containing about 3.7 acres, was planted. We do not propose, in this brief review, to attempt to give in detail Mr. Allardice's minute description of the methods followed in raising the trees from seed, transplanting them to their final location on the reservoir reservation, and caring for them during the early years of their growth. Dealing first with the conifers, however, we may say that they were raised from seed in drills, and were transplanted at the end of one year into transplant beds, where they were spaced about 4 inches apart in rows 6 inches apart and left from one to three years. Field planting was done in both spring and fall, with no apparent difference in the results obtained. The maximum cost of this work was $7.87 per thousand trees; this was in heavy grass land. Under average conditions, with a well organized and experienced gang, two men will plant about 2,000 trees per 9-hour day, at a cost, including the nursery work, of about $3.25 per thousand trees. Remarkably successful results have been obtained with the white pine and other conifers, 90 per cent. of the trees placed in the field having lived.

The raising of hardwoods, maple, oak, chestnut and walnut, on the other hand, has largely failed. The first seedlings planted were transferred directly from the nursery to the field at the age of one year. Nearly all these trees died and their failure was attributed to the early age at which they were planted. Subsequently transplanting was practiced, and while the seedlings seemed to improve in the transplant beds, they continued to die rapidly in the field. The conclusion was finally reached that the soil in the nurseries was not suited to growing hardwoods and finally their culture was abandoned.

TABLE OF WORK ACCOMPLISHED TO DECEMBER 31, 1908.

Total area of nurseries	8.0 acres
Total area planted	1,330 acres
Total number of trees planted: coniferous	948,000
deciduous	902,000
Total length of reservoir margin planted	32 miles
Total length of fire guard cleared and maintained	20.8 miles
Total length of forest roads cleared and maintained	30.0 miles
Planted area thinned	488 acres
Original timber stands thinned	209 acres

TABLE OF COSTS. WAGE RATE, $1.75 PER EIGHT-HOUR DAY.

Nurseries:	
Clearing nursery on south shore	$200.00 per acre
Maintenance of nursery, first year seedlings	$1.50 per M.
Maintenance of nursery, second and third year seedlings	$1.75 per M. per year
Plantings:	
Clearing areas preparatory to planting	$4.00 per acre
Transplanting seedlings from nursery to field	$5.25 per M.
Transplanting seedlings from nursery to field, 6 feet by 6 feet planting	$5.50 per acre
Improvement thinnings:	
Among planted trees	$6.00 per acre
In original timber stands	$20.00 per acre
Fire protection:	
Clearing marginal fire guard 40 feet wide	$150 per mile
Maintaining marginal fire guard	$27 per mile per year
Clearing and grading forest roads 15 feet wide	$120 per mile
Maintaining forest roads	$8 per mile per year
Maintaining fire patrol	$100 per year

REFORESTATION. SUMMARY OF COSTS ON PLANTED PINE STANDS.

	Per 1,000 trees planted.	Per acre planted.
Preparing nurseries	$0.40	$0.60
Seedlings (1 year)	1.50	2.25
Transplants (2 years)	3.50	4.50
Preparatory clearing	3.00	4.00
Field planting	5.25	5.50
Clearing 40-foot fire guard	0.75	1.00
Clearing 15-foot forest roads	1.00	1.35
Maintaining fire guard, per year	0.14	0.19
Maintaining forest roads, per year	0.06	0.09
Maintaining fire patrol	0.02	0.03
Improvement clearing	4.25	6.00

"The original condition of the area to be treated being so varied, it was necessary to vary the composition of the artificial stand to meet the requirements of the individual lot. In the main, the plantings comprised white pines planted 10 feet by 10 feet apart, using oaks, chestnuts and maples as fillers, making the final stand with trees 5 feet by 5 feet apart, the theory of this composition being that the hardwoods, growing so much faster than the pines, would thrash their young and tender limbs, thereby forcing them to grow upwards and developing a long, straight, clear log. This type of planting required 435 pines and 1,307 hardwood trees per acre and was used in arable, open pasture and light sprout land. In the thick sprout and young, thinly grown timber land, the pine seedlings were used to underplant the sprouts and interplant the open spaces of the timber land. The first plantings were made during 1902, and from then up to the time that the failure of the hardwoods was discovered (1906), the mixed type of planting was used. Since that time no hardwoods have been planted and the pine seedlings have been spaced 6 feet by 6 feet apart in the field. This spacing required 1,210 trees per acre."

Improvement thinning of the sprout and scrub lands was found necessary to give the young pines light and air. The aim was ultimately to secure a sound, healthy stand of pure white pines, having from 250 to 350 trees per acre. The method of improvement thinning adopted was to cut out all growth that might in any way stunt or kill the trees. Similar thinning was practiced in the existing timber stands. The fire roads require cutting over once every year.

"The tables show that it costs about $15.40 per thousand trees, or $19.20 per acre (1,390 trees per acre), to raise the trees from seed, prepare, plant and protect the lands planted through the time of final planting in the field; that it costs about 22 cents and 31 cents per year respectively to maintain efficient fire protection; that in sprout and scrub land it costs about $4.25 and $6.00 respectively for an improvement thinning, which will probably have to be made twice during the first ten years, after which time the trees should care for themselves."

DRYING BLAST WITH CALCIUM CHLORIDE.

A BRIEF DESCRIPTION OF A NEW PROCESS FOR THE DESSICATION OF BLAST-FURNACE AIR.

F. Daubiné and E. Roy—Bulletin de la Société de l'Industrie minérale.

AFTER a long series of investigations, two French metallurgists, MM. F. Daubiné and E. Roy, have succeeded in developing a cheap and efficient process for drying blast-furnace air by means of calcium chloride, which they describe in full in the *Bulletin de la Société de l'Industrie minérale* for November and December, 1909. They were first attracted to the problem by the success of the Gayley refrigerating process at Cardiff. Taking the case of a blast furnace with an output of 130 tons per day using moist air, located in Lorraine at a considerable distance from a source of coke supply, MM. Daubiné and Roy calculated that by drying the blast the output of the furnace could be increased to 150 tons per day and at the same time the cost of production could be reduced by from 40 to 60 cents per ton. For a plant of this size, however, the Gayley process was much too expensive, both in first cost and in cost of operation. The expense of installing a refrigerating plant would be at least $60,000, and the operation, maintenance and depreciation cost would be very close to 40 cents per ton.

In the hope of discovering a less costly process, MM. Daubiné and Roy took up the systematic study of hygroscopic substances. They found that calcium chloride, the cheapest, most active, and most easily handled of all hygroscopic materials, is capable of retaining at least as much water as is extracted from the air by the Gayley refrigerating process, and, further, that the regeneration of saturated calcium chloride can be effected by very simple means, merely by the application of heat. In designing apparatus for utilizing the hygroscopic properties of calcium chloride for drying air, and for regenerating the spent material, it was found necessary to take into account certain practical considerations. The hygroscopic power of calcium chloride is greater at low temperatures. In the interests of economy, therefore, it is necessary to effect the drying process before the air reaches the blowing engines; otherwise the air, being heated during compression, would have to be re-cooled before entering the drying apparatus. Further, calcium chloride becomes heated in the process of absorbing moisture and in order to keep down the temperature of the mass, the grating on which it is carried must be cooled by the circulation of cold water. The rate of absorption of the chloride falls as drying progresses; hence the speed of the air passing through the mass must gradually decrease, necessitating a gradual increase in the sectional area of the dehydrating mass. The hydrated mass formed on the surface of fragments of calcium chloride is fluid and has a tendency to run; the air must be passed downward through the mass of chloride, so that if the hydrated mass becomes fluid enough to flow, it will be caught and held on the less hydrated fragments below. Finally, to preserve its efficiency, the calcium chloride must be protected against contamination. If furnace gas is to be used to regenerate the spent material, it cannot be allowed to operate directly on the surface of the chloride on account of the danger of dust being deposited in such quantities as to destroy the hygroscopic power of the substance. In addition to this danger, there is a considerable risk of converting a portion of the chloride into carbonate by the action of carbon dioxide.

The process developed by MM. Daubiné and Roy take account of all these considerations. Each apparatus is composed of ten similar and superimposed units, measuring about 10 feet square and 16 inches in height. Each unit has three elements: (1) a grating of water-cooled, externally ribbed tubes, which carries the calcium chloride; (2) a series of tubes, triangular in section, imbedded in the chloride and resting on the grating on one of their edges, through which furnace gases are passed; and (3) two flat sheet-iron chambers,

one located at the moist-air intake, the other at the dry-air outlet.

The air to be dried is impelled by a fan into a distributing conduit, whence it is distributed among the intake chambers mentioned above, and from these chambers it passes into the various units of the apparatus. The air then passes downward through the mass of the chloride, which offers to the air a gradually increasing section, as the free air space between the triangular tubes for the heating gases increases progressively downward, from 58 square feet at the top to 97 square feet at the bottom. The dried air passes into another collecting chamber, whence it is led to the intake of the blowing engine. The intake of the moist air and the outlet of the dry air are placed in diametrically opposite positions, to ensure equality of resistance to the passage of the air in all the units, and to prevent any short circuiting, which would cause unequal deposition of moisture.

In the regenerative process the hot gases are led from the flue into a distributing chamber, whence they are distributed among the different sets of triangular tubes. After passing through the tubes they enter another chamber which communicates either with a chimney or with an exhaust fan. During the passage of the heating gases through the triangular tubes a second fan draws through the chloride a regenerating current of air in a direction opposed to that of the air going to the blowing engines. By regulating the speed of this fan, the temperature of the mass of chlorine can be adjusted to effect progressive heating, and it can be prevented from rising above 235 degrees C., the maximum limit permissible.

Each blast furnace is provided with four apparatus of the type described. At any given time, one is in operation for drying the blast, one is being heated to dry the chloride, one is being cooled and the fourth is held in reserve or is being repaired or cleaned. The operation of each set is changed at stated intervals, for example, every hour. The substitution of the regenerative process for the drying process is effected by shutting off communication with the air fan, opening the admission and outlet valves for the heating gases, and opening the valve leading to the small fan which produces the regenerative air current. The heating of the calcium chloride is carefully observed by means of pyrometers inserted in the mass. To start the recooling process, all openings are closed and a very rapid current of air, in volume not more than a few hundred cubic feet per hour, is drawn through the gratings.

The type of apparatus described above is especially suited to works where no surplus motive power is available and where it is necessary to utilize the heat of the furnace gases in the most efficient and economical manner. In plants which have a large surplus of furnace gases, as is the case in many ironworks producing pig iron alone, it may be more economical to waste the furnace gases used in the drying process for the sake of obtaining convenience of construction and facility of operation of the drying apparatus. For such plants MM. Daubiné and Roy propose a second and simpler form of apparatus. The triangular heating tubes within the mass of the chloride are omitted and the units of the drying apparatus consist of only the water-cooled grating and the hygroscopic material. The drying of the air is effected in the manner already described, but the regeneration of the chloride is carried out by a different procedure. The drying air from the secondary fan is passed through an apparatus resembling a Green economizer. The air flows through a series of externally ribbed tubes surrounded by hot furnace gases or by a similar heating medium. Heated thus it is drawn upward through the mass of spent chloride. At the temperature at which the air leaves the economizer (235 degrees C.) it is capable of absorbing very large quantities of water vapor and acts on the chloride both as a heating and as a drying agent. One economizer is provided for the four drying units of each blast furnace and operates continuously, the hot air being drawn into each unit in turn, as occasion requires.

The researches of MM. Daubiné and Roy have been carried out on an experi-

mental apparatus, with an output of 3,500 cubic feet of air per hour. Under average conditions it has been found that the calcium chloride easily dessicates ten times its own weight of air. Allowing a margin of 100 per cent. on the quantity of chloride required, the first purchase will not exceed 25 long tons, at a cost of $500. The total cost of the equipment for each furnace, including the 30 and 20 horse-power fans required, will not exceed $10,000 The material being non-volatile, the waste of calcium chloride must be small, but even if the supply had to be renewed every ten days, the cost would be only $10 per day. The apparatus would require the attention of only one man per shift, and the power and labor costs would be small, not more than $11 per day. Including an allowance of 4 per cent. for depreciation, the total cost, as estimated by MM. Daubiné and Roy for a furnace with a daily output of 150 tons, is $24.40 per day, or 16 cents per ton. The Gayley process, with refrigerating machinery, costs 39 cents per ton, so that the balance in favor of the calcium-chloride process is 23 cents, a saving of over 50 per cent.

MECHANICAL GEARING FOR MARINE TURBINES.

AN APPLICATION OF THE MARINE STEAM TURBINE AND MECHANICAL GEARING IN A MERCHANT SHIP.

Hon. C. A. Parsons—Institution of Naval Architects.

THE use of mechanical gearing as a solution of the problem of adjusting propeller to turbine speed in marine-turbine propulsion has been brought into prominence during the last few months by the reports published in the technical press of the Melville-Macalpine-Westinghouse double-helical spur gear, a description of which has already appeared in these columns.* This system of gearing, however, is not the only one which has been devised for the purpose. In a paper read at the recent meeting of the Institution of Naval Architects, which is reprinted in *Engineering* for March 25, Hon. C. A. Parsons describes the substitution of turbines and mechanical gearing for reciprocating engines in a typical, slow-speed (10 knots) merchant vessel, and gives a summary of the results obtained in trials of the vessel at sea.

The success of the experiment is of very great significance. As remarked by Professor Biles in the discussion on Mr. Parsons' paper, in high-speed ships a satisfactory compromise has been arrived at between the speed of the propeller and the turbine; while in ships of intermediate speed the combined system of reciprocating engines and turbines has proved satisfactory. Mr. Parsons' paper indicates that a new field is about to be invaded by the steam turbine—that of slow-speed vessels. How imminent the invasion is, may be judged from the following discussion of the experiment and of the economy of the gearing system, as disclosed by the results of sea trials.

"In the summer of last year the directors of the Turbinia Works Company decided to test turbines mechanically geared to the screw shaft of an existing typical slow-speed vessel, and a cargo vessel named the *Vespasian* was purchased for this purpose. The *Vespasian* was built in 1887. Her dimensions are:—Length, on load water line, 275 feet; breadth, moulded, 38 feet 9 inches; depth, moulded, 21 feet 2 inches; mean loaded draught, 19 feet 8 inches; and displacement, 4,350 tons.

The vessel had originally an ordinary triple-expansion, surface-condensing engine, with cylinders 22¾ inches, 35 inches, and 59 inches in diameter, by a 42-inch stroke. The air, circulating, feed and bilge pumps were driven from the intermediate-pressure cross head, with the usual arrangement of levers and links. The condenser was cast with the back columns of the main engine, and had a cooling surface of 1,770 square feet. The boilers—two in number—are 13 feet in diameter by 10 feet 6 inches long, with a total heating surface of

*THE ENGINEERING MAGAZINE, November, 1909.

3,430 square feet, and grate area of 98 square feet, working under a pressure of 150 pounds with natural draught. The propeller is of cast iron, and has four blades, having a diameter of 14 feet, a pitch of 16.35, and an expanded area of 70 square feet.

"With a view to obtaining comparative data between the turbine installation and the reciprocating engine, it was decided to run trials with the vessel with her reciprocating engine previous to its removal, and the installing of the turbines and gearing. Before proceeding on the voyage upon which data regarding the performance of the reciprocating engine were taken, the propelling machinery was completely dismantled and overhauled. The high-pressure piston valve-chamber was re-bored and new valve-rings fitted; slide-valves were replaced and faced up; bearings were renewed, and other repairs carried out wherever necessary to bring the machinery into an efficient condition and first-class working order. To obtain reliable measurements of water consumption, two tanks were fitted, each of 400 gallons capacity, with suitable change-cocks and connections for the air-pump to discharge through these measuring tanks.

"It was necessary, for the purpose of obtaining data under service conditions, that the vessel should be run at her loaded condition. Arrangements were consequently made with a firm of ship-brokers to take a cargo of coal from the Tyne to Malta, and on June 26, last year, the *Vespasian* left the Tyne, in a loaded condition, with a special recording staff on board, and on this voyage careful measurements of coal and water consumption were made.

"On the completion of the voyage, the vessel returned to the Turbinia Works, where her reciprocating engine was taken out, engine-seats remodeled, and preparation made for the reception of the turbines and gearing. The only alteration made to the vessel was in the type of propelling engines; the boilers, propeller, shafting, and thrust-blocks remained the same as for the reciprocating engine. The propelling machinery consists of two turbines in 'series'—viz., one high-pressure and one low-pressure, the high-pressure turbine being placed on the starboard side of the vessel and the low-pressure on the port side. At the after end of each of the turbines a driving pinion is connected with a flexible coupling between the pinion shaft and the turbine, the pinion on each side of the vessel being geared into a wheel, which is coupled to the propeller shaft.

"A reversing turbine is incorporated in the exhaust casing of the low-pressure turbine. The air, circulating, feed, and bilge pumps are of the usual design for tramp steamers, and are driven by means of a crank and connecting rod coupled to the forward end of the gear-wheel shaft. The turbine and pinion-shaft bearings are under forced lubrication, as in ordinary turbine practice. The teeth of the pinions and of the gear wheel are lubricated by means of a 'spray' pipe extending the full width of the face of the wheel. Independent oil pumps are fitted for supplying oil to the bearings and gear wheel. With a view to the possibility of experimenting with different lubricants for the gear wheel, the oiling system for the bearings is separate from that of the gear wheel.

"The high-pressure turbine is 3 feet maximum diameter by 13 feet over-all length, and the low-pressure 3 feet 10 inches in diameter by 12 feet 6 inches length. The turbines are similar in design to a land turbine, being balanced for steam thrust only, the propeller thrust being taken up by the ordinary thrust block of the horse-shoe type, which is fitted aft of the gear wheel. A new condenser, together with a vacuum augmentor, is fitted with the turbine installation. The cooling surface of the condenser is 1,165 square feet.

"The gear wheel is of cast iron, with two forged steel rims shrunk on. The diameter of the wheel is 8 feet 3½ inches pitch circle, having 398 teeth—double helical—with a circular pitch of 0.7854 inch. The total width of the face of the wheel is 24 inches; the inclination of teeth 20 degrees to the axis. The pinion shafts are of chrome nickel steel, 5 inches in diameter pitch circle, with twenty teeth 0.7854 circular pitch. The ratio of gear is 19.9 to 1."

After the reciprocating engine of the *Vespasian* had been overhauled, and before she was sent on her voyage to Malta, a series of trials was made on the Whitley Bay mile. On the completion of the turbine-gearing equipment another series of trials was run with the vessel loaded to the same draught and displacement as in the Whitley Bay trials. Mr. Parsons gives in tabular form the results of the two series of trials, and also a graphical comparison of the results in a series of charts plotted from the tabular data. Without reproducing the results in detail, we may summarize their more significant features. The speed was increased by one knot per hour, owing to the higher efficiency of the turbines, while at the same time the water consumption, and consequently the coal consumption, was reduced nearly 20 per cent. The weight of the reciprocating machinery was 100 tons, as compared with 75 tons for the new installation, a saving of 25 per cent. The results show, therefore, that the installation of mechanically geared steam turbines in slow-speed merchant vessels gives them, in comparison with vessels with reciprocating engines, the advantage of additional capacity, and a saving in coal and oil, in engine-room staff, and in upkeep, the latter following the lower working steam pressure.

The turbines and gearing have given little or no trouble, and have worked satisfactorily, with very little noise or vibration, throughout the trials. Further, there is no appreciable wear on the teeth or bearings. It is proposed to put the vessel into commercial service and run extended trials, the results of which will be watched with very considerable interest.

BRITTLENESS IN MILD STEEL.

THE RESPONSIBILITY OF COMBINED NITROGEN FOR FAILURES OF MILD-STEEL PLATES.

C. E. Stromeyer—Institution of Naval Architects.

THE investigation of the causes of failure of mild-steel plates is a field which Mr. C. E. Stromeyer has made peculiarly his own. His work as chief engineer of the Manchester Steam Users' Association has given him unusual opportunities for collecting data at first hand, and even before the modern theory that brittleness is attributable to the influence of combined nitrogen was propounded about four years ago by M. Hjalmar Braune, Mr. Stromeyer's annual reports rarely failed to summarize the best available information on the subject. One of these reports was abstracted in the columns of THE ENGINEERING MAGAZINE for December, 1906. This report contained no mention of Braune's results, but all of Mr. Stromeyer's subsequent work has taken account of the nitrogen theory, and it is not too much to say that its confirmation has been largely due to his investigations. A summary of present knowledge is given in a paper read by Mr. Stromeyer at the recent meeting of the Institution of Naval Architects, from which we quote at length.

"During the last few years I have been engaged on rather exhaustive experiments with mild steel plates, some of which had come out of exploded boilers, while others had failed in the workshop and yet others were of good quality. These experiments were undertaken to ascertain, if possible, whether any mechanical tests could be relied upon to discriminate between such plates as behave well both when tested and subsequently and such as behave well when tested but fail either in the workshop or when put to use in a boiler. The mere statement of this aim implies a suspicion that a structural or molecular change may take place in mild steel while at rest, and my attention was naturally at first directed toward discovering whether any steels possessed ageing qualities. A test was devised which consisted in planing the edges of the test pieces, nicking them with a chisel, and then bending them, either at once or after waiting days, weeks or months, or after boiling the samples for a few minutes at a temperature of 212 degrees F., which boiling, so it was found, has the same effect

as prolonged waiting. The change of ductility at the nick, where the material has been as much injured as when plates are calked, could easily be detected by measuring the curvatures near the nicks, the edges having been filed flat before bending.

"Marked ageing effects were noticed in 24 out of 26 steels dealt with. One of the two exceptions (but this is a doubtful case) was a chrome vanadium steel, and the other sample was exceptionally rich in sulphur. Samples containing much phosphorus did not seem to be as much affected by ageing and boiling as the other samples, and no marked difference could be detected between steels which had failed in practice and others of presumably good quality. Temper and cold bending tests, percussion tests, alternate bending tests and fatigue tests did not help to detect those steels which had failed in practice, nor did the ordinary chemical analysis help to elucidate matters; and it was only when, after having heard of M. Braune's investigations into the effect of nitrogen on steel, this element was also determined in analysis of the steels, that light was thrown on the cause of most of the failures of plates which I had collected."

TABLE OF DEFECTIVE STEELS.

Steel qualities.	Plate marks.	Carbon, per cent.	Nitrogen, per cent.	Phosphorus, per cent.	5 nitrogen + phosphorus.
Bad qualities of steel	Q	0.127	0.0200	0.052	0.152
	L	0.090	0.0153	0.060	0.136
	H	0.210	0.0145	0.079	0.151
	C C	0.130	0.0123	0.047	0.108
	M	0.090	0.0090	0.052	0.097
	U	0.110	0.0066	0.052	0.085
	F	0.097	0.0043	0.210	0.231
	R	0.165	0.0030	0.177	0.192
	K	0.205	0.0041	0.095	0.115
	E	0.165	0.0029	0.076	0.090
	S	0.135	0.0038	0.065	0.084
Uncertain	T	0.200	0.0023	0.038	0.049
Basic O. H. steels.	G	0.215	0.0050	0.051	0.076
	Z	0.195	0.0033	0.039	0.055
Acid O. H. steels.	B	0.200	0.0040	0.032	0.052
	B B	0.200	0.0032	0.029	0.045

Data are given of the process of manufacture and nature of the failure of the plates tested. "The list given above contains those of the steels which actually failed or which were so bad as not to be sent to the boiler works and also a few good steels for comparison. Samples G and Z are basic open-hearth steels, respectively of German and British make, and B and B B are acid open-hearth steels, also of German and British makes respectively. The table contains the leading chemical impurities, and in the last column will be found the sums of the percentages of phosphorus added to five times the percentages of nitrogen. This ratio in the relative brittleness influences has been adopted, partly because it is the inverse ratio of the squares of the respective atomic weights of the two elements and partly because nitrogen has a ten-fold greater effect than phosphorus in raising the tenacity of steel, an addition of 0.01 per cent. increasing the tenacity by about 3 tons. It has been assumed that the relative brittleness effects of the two elements may be even greater than 10 to 1, but are at least as great as 5 to 1, which is the adopted ratio.

"Until quite recently nothing was known about the brittleness effect of nitrogen on steel; as regards phosphorus, 0.060 per cent. was looked upon as a reasonable upper limit, and steel plates containing more than this percentage were expected to give trouble in the works due to cold shortness. This view has now to be modified; at any rate, sample C C, which was undoubtedly a very bad quality, possibly produced by the same process as the notorious boiler plates of the Imperial Russian yacht *Livadia*, contains only 0.047 per cent. phosphorus, but it also contains 0.0123 per cent. nitrogen, which is more than twice as much as that contained in any of the good steels. Then again Q, which was cut from a boiler plate which also burst under the hydraulic test, contained only 0.052 per cent. of phosphorus but 0.0200 per cent. of nitrogen, which is four times as much as that contained in any good steels. A safer rule to go by than the above is based on the values contained in the last column of the table and may at present be expressed as follows: The sum of the percentage of phosphorus plus five times the percentage of nitrogen should not exceed 0.080 per cent.

"A further conclusion to be drawn from this investigation is that: No investigation into the cause of the failure of a mild steel plate can be considered complete unless both the phosphorus and

nitrogen percentages have been determined. The nitrogen determination is extremely simple and rapid, but every possible precaution has to be adopted to guard against contamination by ammonia either in the reagents or in the atmosphere. . . . . .

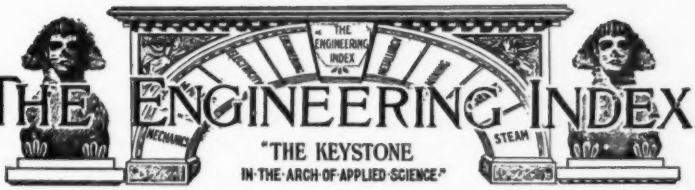
"A very natural question to ask is, When does the nitrogen get into steel, and how can it be removed when it has got there? The most natural explanation would be that nitrogen is introduced by the contact of molten steel with the nitrogen of the air blasts in the blast furnaces and in the Bessemer converters. This is partly confirmed by the following comparison of Bessemer steels of the above lists with other steels and wrought irons:

"Percentages of nitrogen in Bessemer steels: (L) 0.0153, (H) 0.0145, (60) 0.0108, (20) 0.0160, (40) 0.0150. Percentages of nitrogen in open hearth acid and basic steels of previously mentioned samples, 0.0024 to 0.0050 per cent. Other mild steels: (25) 0.0042; steel forging, 0.0022; bad wrought iron with 0.219 per cent. phosphorus, 0.0084 per cent. nitrogen; charcoal iron, 0.0035.

"In spite of this confirmation of a very natural view on the subject, it has to be borne in mind that as yet it has not been possible to combine nitrogen with steel by merely heating the two together, and that the only means of effecting the combination is to heat steel in an atmosphere of ammonia. Now ammonia is not introduced into Bessemer converters, but it may be present in blast furnaces if the coking of the fuel has not entirely removed the nitrogen which was in the coal. Then, also, it seems as if nitrogen, when once it has entered the pig iron in the blast furnace, cannot be removed by subsequent heating. The suitable chemical for effecting the removal is believed to be titanium, but the addition of ferro-titanium alloy to steel has not demonstrated that this beneficial action takes place. This is probably due to the necessary temperature conditions being as yet unknown, but nevertheless a strong argument in favor of the belief that titanium can remove or keep down the percentage of nitrogen was recently brought to my notice by the discovery inside the now dismantled blast furnaces of the Farnley Iron Company of some crystals of titanium nitride. To my mind, unsuspected traces of titanium in the Farnley iron ores may have been the reason why the product always enjoyed a high reputation for reliability.

"Under these circumstances it seemed desirable to ascertain more definitely how titanium acts in practice, but it was only with great difficulty that the necessary samples could be obtained. It appears that attempts to introduce titanium by adding its ores in the blast furnace have not been a success, nor have additions of titanium ores or titanium iron alloys to molten steel or cast iron resulted in marked improvements, and in none of these cases has the nitrogen percentage been determined. Of late, however, since the production of practically pure titanium has been effected, its addition to steel and cast iron has been attended with varying degrees of success, more particularly in removing blow holes, and I have been able to analyze one pair of cast steel samples and a pair of cast iron samples. Unfortunately, the original charge of cast iron contained very little nitrogen, viz., 0.0014 per cent., but even in this case the addition of 0.2 per cent. of titanium reduced the nitrogen to 0.0013 per cent., but the slight difference is smaller than the possible errors of analysis. Of the two cast steels the untreated one contained 0.0063 per cent., which was reduced in the other sample to which titanium had been added to only 0.0045 per cent. Further attempts in this direction may perhaps lead to the removal of nitrogen from Bessemer steel and thus make it available for plates.

"It may be thought that the brittlenesses, which have here been attributed to nitrogen, are due to hydrogen, for it is known that this gas imparts extraordinary hardness to otherwise pure iron, but it is also known that hydrogen is easily driven out by heating the steel, and it is, therefore, improbable that appreciable quantities of hydrogen should remain after melting and reheating for rolling."



The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING.

BRIDGES.

Abutments.

See Piers, under BRIDGES.

Arches.

Tests of Model Concrete Arches by the New York State Engineer's Office. Description, with illustrations, forming a portion of a report in the *Barge Canal Bul.* for Feb. 3500 w. Eng News—March 10, 1910. No. 12215.

See also Aqueducts, under WATER SUPPLY.

Concrete.

Comments on Contracting for Concrete Bridges with Description of a Form of Cost Recording. Extract from a paper by Daniel B. Luten, read before the Am. Soc. of Engng. Con. 1600 w. Engng-Con—March 2, 1910. No. 12100.

Short-Span Single-Track Concrete Arch Bridges. Bridges on the Lake Champlain & Moriah Ry. are illustrated and described, giving costs. 1200 w. Eng Rec—March 19, 1910. No. 12369.

We supply copies of these articles. See page 317.

Deflection Tests.

Deflection Tests of Railway Bridges. Conrad Gribble. An illustrated study of tests and loadings. 4000 w. Cassier's Mag—March, 1910. Special No. No. 12514 D.

Failures.

A Reinforced-Concrete Arch Highway Bridge in Indiana Wrecked by Erosion of Foundations. Illustrates and describes the structural design and failure of the Pugh's Fork bridge, over the Flat Rock river, near Edinburg, Ind. 1600 w. Eng News—March 17, 1910. No. 12311.

Piers.

The Substructure of the P. & L. E. R. R. Bridge Over the Ohio River at Beaver, Pa. A. R. Raymer. Explains reasons for building this new bridge, and gives illustrated description of the substructure, consisting of two abutments and three piers of concrete, faced in part with sandstone. 6000 w. Pro Engrs' Soc of W Penn—Feb., 1910. No. 12547 D.

Reconstruction.

Strengthening of Railway Bridges in America. George Sherwood Hodgins. Illustrates and describes methods of reconstruction to meet the demands of greater traffic and heavier rolling stock. 2500 w. Cassier's Mag—March, 1910. Special No. No. 12520 D.

Reconstruction of Boylston Street Bridge at Boston. Illustrated detailed description of the conditions which led to the deterioration and the means adopted for the restoration under difficult conditions and for its future protection. Also editorial. 5500 w. Eng Rec—March 5, 1910. No. 12143.

The Atbara Bridge. An account of the proposed method of strengthening this bridge to meet the present requirements. by renewing the main girders. 1200 w. Engr, Lond—March 11, 1910. No. 12501 A.

Reinforced Concrete.

A Reinforced Concrete Sewer Bridge. Henry Ryon. Illustration with brief description of a construction at Morristown, N. J. 1000 w. Eng Rec—March 26, 1910. No. 12662.

Reinforcement of Fulmer Creek Bridge with Steel and Concrete. Illustrates and describes methods of reinforcement of the bridge on the Utica & Mohawk Valley R. R., made necessary by the use of heavier equipment. 1200 w. Elec Ry Jour—March 26, 1910. No. 12652.

Three-Hinge Reinforced Concrete Arch Over Schöneberger Street, Gaarden (Dreigelenkbogenbrücke in Eisenbeton über die Schöneberger Strasse in Gaarden). J. Gaugusch. Mathematical discussion of the design of a unique foot bridge. Ills. 3000 w. Beton u Eisen—Feb. 20, 1910. No. 12494 F.

See also Failures, under BRIDGES.

Steel.

Two Bridges in Berlin. Montgomery Schuyler. Discusses bridge design and illustrates the "Borsigsteg" and the Swinemuende bridge. 2500 w. Archt Rec—March, 1910. No. 12022 C.

Railway Bridge Over the Nami-Ti Gorge. Brief illustrated description of a peculiar and ingenious bridge on the Yun Nan Railway, China. 700 w. Engr, Lond—March 18, 1910. No. 12742 A.

Steel Bridges on the Yun-Nan Railway, China (Les Ponts Métalliques au Yun-Nan, Chine). Georges Bodin. Illustrated description of the Nam-Ti bridge, of a curious type. 3500 w. Génie Civil—Feb. 12, 1910. No. 12438 D.

See also Reconstruction, under BRIDGES.

Trestles.

Albemarle Sound Bridge, Norfolk & Southern Ry. Explains conditions and gives an illustrated detailed description of a pile trestle with two large movable spans and five fixed spans. 2500 w. Ry & Engng Rev—Feb. 26, 1910. No. 12023.

Viaducts.

The Shepherdstown Viaduct, Norfolk & Western Railway. Illustrated description of single-track steel structure across the Potomac River, 1438 ft. long. 1200 w. Eng Rec—March 19, 1910. No. 12368.

CONSTRUCTION.

Arches.

See Roofs, under CONSTRUCTION.

Beams.

The Influence of Holes or Slits in the Neutral Axis on the Strength of Beams (Der Einfluss von Löchern oder Schlitzen in der Neutralschicht gebogener Balken auf ihre Tragfähigkeit). C. Pfleiderer. Mathematical discussion with results of tests. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 26, 1910. No. 12616 D.

See also Columns, under CONSTRUCTION.

Coal Pockets.

Coal Pockets at the Lausanne Gas Works (Les Silos de l'Usine à Gaz de la Ville de Lausanne). S. de Mollins. Describes interesting reinforced-concrete construction. Ills. 1000 w. Bul Tech d l Suisse Rom—Feb. 10, 1910. No. 12425 D.

Columns.

A Study of Base and Bearing Plates for Columns and Beams. N. Clifford Ricker. Aims to produce a series of accurate formulae and tables for the different forms and materials of base and bearing plates; and to devise a similar series of formulae based on the common theory of fracture of such plates, testing the accuracy. Ills. 3500 w. Univ of Ill—Bul. 35. July 28, 1909. No. 12318 N.

See also Reinforced Concrete, under CONSTRUCTION.

Concrete.

A Method of Depositing Concrete by Chutes in Building Construction with

Costs of Actual Work. Illustrated description. 1500 w. Engng-Con—March 30, 1910. No. 12764.

Method of Laying Concrete Under Water Using a Tremic; Detroit River Tunnel. Olaf Hoff. Read before the Nat. Assn. of Cement Users. Considers briefly the laying concrete under water by means of bags and by drop-bottom buckets, and the difficulties in depositing by means of tremics, and how they were overcome. 2200 w. Engng-Con—March 2, 1910. No. 12101.

See also Roofs, under CONSTRUCTION.

Concrete Blocks.

See Roads, under MUNICIPAL ENGINEERING.

Demolition.

Demolition of the Old Union Station at Worcester. C. H. Gilman. Brief illustrated description of methods used. 600 w. Eng Rec—Feb. 26, 1910. No. 12027.

Excavation.

Some Records of Work With a Scraper Bucket Excavator on the New York Barge Canal. A record of work accomplished by a Class C, Lidgerwood-Crawford scraper bucket excavator. 1000 w. Engng-Con—March 23, 1910. No. 12575.

See also Rock Removal, under WATERWAYS AND HARBORS.

Failures.

See same title, under BRIDGES; Dams, under WATER SUPPLY; and Canal Regulators, under WATERWAYS AND HARBORS.

Floors.

A Method of Long Span, Light Floor, Reinforced Concrete Construction, with Comparative Costs. Emile G. Perrot. Read at convention of Nat. Assn. of Cement Users. Describes a method of interest because of the unusual length of the span. 900 w. Engng-Con—March 2, 1910. No. 12098.

Grain Elevators.

An Investigation of Grain Pressures at Buenos Aires (Druckversuche in Buenos Aires). E. Lufft. Describes methods and results of investigations to determine the pressure of grain in cylindrical bins. Ills. 2800 w. Beton u Eisen—Feb. 20, 1910. No. 12496 F.

Greenhouses.

Inside-Glazed Greenhouses in the Berlin Botanical Gardens. Illustrations and brief description of greenhouses in which the trusses and all other framing is outside the glass roof, to remove them from the action of the most interior atmosphere. 800 w. Eng News—March 17, 1910. No. 12306.

Indeterminate Stresses.

Stress-Lines and Stream-Lines. Examines the assumed analogy between stress-lines and stream-lines, pointing out the deficiencies. 2500 w. Engng—March 11, 1910. No. 12393 A.

Pile Driving.

The Bucyrus Locomotive Pile Driver. Discussion of Walter Ferris' paper describing a new railway pile driver. 1000 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12357 F.

Piling.

Cement and Concrete for Protecting Piles in Sea Water. Ralph Barker. Read before the Nat. Assn. of Cement Users. Reviews methods of pile protection, describing especially the use of cement and concrete as applied at San Francisco. 2500 w. Eng Rec—March 26, 1910. No. 12665.

Regulations.

Standard Building Regulations for the Use of Reinforced Concrete. Gives the code voted on in 1909, and amended last week at the Chicago convention of the Nat. Assn. of Cement Users. 4000 w. Eng Rec—March 5, 1910. No. 12141.

Reinforced Concrete.

The Problems of Reinforced Concrete (Problemi attuali sul Cemento armato). Giulio Revere. A brief outline of salient points in reinforced-concrete theory, including methods of testing, structural regulations, etc. 3000 w. Monit Tech—Jan. 30, 1910. No. 12446 D.

Some Mooted Questions in Reinforced Concrete Design. Edward Godfrey. Criticism of present practice in the use of reinforcing rods, stirrups in beams, and other points. 7000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12654 E.

Methods of Calculation of Reinforced-Concrete Structures (Rechenverfahren bei Eisenbetonkonstruktionen). Herm. Hartmann. Mathematical discussion of the design of floor beams. Ills. 4500 w. Beton u Eisen—Feb. 20, 1910. No. 12495 F.

A Simple Method of Computing the Strength of Flat Reinforced Concrete Plates. Angus B. McMillan. Read before the Nat. Assn. of Cement Users. Gives a description of the different methods used to compute the stresses in the "mushroom floor" designed by C. A. P. Turner. 5500 w. Engng-Con—March 23, 1910. No. 12573.

Dimension Formulae for Concrete Mushroom Beams with Single and Double Reinforcement (Dimensionierungsformeln für einfach und doppelt bewehrte Betonplattenbalken). Leopold Herzka. Mathematical discussion with tabular data. Ills. Serial. 1st part. 8000 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 26, 1910. No. 12491 D.

The Calculation of Reinforced Concrete Beams (Sul Calcolo corrente delle Travi a Traliccio con Maglie rettangolari). A. Danusso. Mathematical discussion of a special case. Ills. Serial. 1st part. 2800 w. Il Cemento—Feb. 15, 1910. No. 12448 D.

Longitudinal Reinforcement in Con-

We supply copies of these articles. See page 317.

crete Columns. Sanford E. Thompson. Read before the Nat. Assn. of Cement Users. Shows that tests prove that vertical steel bars embedded in the concrete increase the strength of the column. 2000 w. Cement—March, 1910. No. 12670 C.

Industrial Uses of Reinforced Concrete. M. M. Sloan. This fourth article of a series considers its adaptations to stacks, tunnels, and mechanical equipment. Ills. 2000 w. Engineering Magazine—April, 1910. No. 12686 B.

The Use of Reinforced Concrete in Ice Storage Houses. W. F. Lee. Reviews briefly the history of the use of concrete and reinforced concrete. Discusses its fireproof qualities, its proper construction and cost. 4000 w. Ice & Refrig—March, 1910. No. 12164 C.

Representative Concrete Structures on the New York Barge Canal and Methods of Inspecting, Mixing and Handling Concrete. Russell S. Greenman. Condensed from paper read at convention of Nat. Assn. of Cement Users. Illustrates and describes unusual and difficult work. 3000 w. Engng-Con—March 30, 1910. No. 12767.

Cost of Constructing a Reinforced Concrete Fence Around a Shaft Top. F. Lavis. Illustrated description of the design and construction of a concrete wall around the top of the shaft of the Penn. R. R.'s tunnels at Weehawken, N. J. 1400 w. Engng-Con—March 30, 1910. No. 12762.

A Reinforced-Concrete Machinery Warehouse. H. Milton Boyajohn. Illustrated description of the construction of a warehouse in Chicago. 1200 w. Eng Rec March 12, 1910. No. 12243.

The New Plant of the Carter's Ink Company. Illustrated description of a reinforced concrete factory building in Cambridge, Mass. 2000 w. Eng Rec—March 19, 1910. No. 12370.

A Twelve-Story Concrete Building Without Interior Columns. W. P. Anderson. Illustrated description of a building recently completed in Kansas City, Mo. 1200 w. Eng Rec—March 5, 1910. No. 12144.

The Bismarck Tower in Glauchau (Bismarkturm in Glauchau). M. Bazali. Illustrated description of floor and wall construction. 2300 w. Beton u Eisen—Feb. 20, 1910. No. 12493 F.

See also Coal Pockets, Floors, and Regulations, under CONSTRUCTION; Tanks, and Water Towers, under WATER SUPPLY; and Shafts, and Shaft Sinking, under MINING AND METALLURGY, MINING.

Retaining Walls.

A Combined Concrete Fence and Retaining Wall. Illustrated description of work in Detroit, Mich., built by the Michigan Central Railroad Co. 900 w. Eng Rec—Feb. 26, 1910. No. 12026.

Roofs.

The Groined Arch in Filter and Reservoir Construction. Thomas H. Wiggin. Read before the Chicago convention of the Nat. Assn. of Cement Users. Discusses methods of considering the groined arch as a support for vertical loads, and matters related. Ills. 3000 w. Eng Rec—March 12, 1910. Serial. 1st part. No. 12241.

Specifications.

Precarious Expedients in Engineering Practice. Discussion of John Hawkesworth's paper. 4500 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12708 E.

Stacks.

Unusual Method of Erecting 90-Foot Stack. Warren O. Rogers. Illustrates and describes the work. 1500 w. Power—March 8, 1910. No. 12169.

Steel.

Cantilever Construction and Wind-Bracing Details in the People's Gas Light & Coke Co. Building, Chicago. A 21-story building having 18 stories carried on cantilevers is illustrated and described Also the wind-bracing system. 800 w. Eng News—March 10, 1910. No. 12220.

Constructing a Building Above an Underground Station. Cross sections and description of a terminal building in Hoboken, N. J., built above a terminal station, where a proper distribution of loads and a limit of bearing value presented difficulties. 1400 w. Eng Rec—March 5, 1910. No. 12146.

The "New York Times" Building. Corydon Tyler Purdy, with abstract of discussion. Illustrated description of the building, discussing special features of its steel construction due to the existence and operation of the Subway. 13000 w. Inst of Civ Engrs, No. 3800—April 20, 1909. No. 12592 N.

Steelwork in the New York Municipal Building. Illustrated detailed description of a building containing about 25400 tons of structural steel. 4000 w. Eng Rec—March 19, 1910. No. 12364.

Steelwork of the Bryant Building, New York. Illustrates and describes the framework of a 30-story building, containing about 3000 tons of structural steel, 2500 w. Eng Rec—March 26, 1910. No. 12663.

Replacement of the Tower of St. Michael's Church in Hamburg (Wiederaufbau des Turmes der St. Michaeliskirche in Hamburg). B. Hennicke. Illustrated description of the design and erection of a new steel tower on the old foundations. Serial. 1st part. 1800 w. Deutsche Bau—Feb. 26, 1910. No. 12474 B.

See also Greenhouses, under CONSTRUCTION.

We supply copies of these articles. See page 317.

Tunnels.

The River Tunnels at New York. J. F. Springer. Illustrated description of the submarine railway tubes for main line service, and their construction. 6000 w. Cassier's Mag—March, 1910. Special No. No. 12523 D.

The New York Tunnel Extension of the Pennsylvania Railroad: The Site of the Terminal Station. George C. Clarke. Describes the preliminary work for, and the preparation of, the site, including the disposal of material excavated. Ills. 14000 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12706 E.

The New York Tunnel Extension of the Pennsylvania Railroad: The Bergen Hill Tunnels. F. Lavis. Illustrated detailed description of the construction, and information relating to the work. 19000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12657 E.

Terryville Tunnel, New York, New Haven & Hartford Railroad. Diagrams and description of the construction of this tunnel near Waterbury, Conn., in connection with improvement of the line. 3000 w. Eng Rec—Feb. 26, 1910. No. 12030.

Constructing the Paris Subway. Lucien Fournier. Illustrated description of the freezing process employed. 1500 w. Sci Am Sup—March 26, 1910. No. 12645.

An Instrument for Measuring and Recording Tunnel Sections. Illustrated description of a tunnel cross-section instrument which automatically plots the cross-section on a reduced scale. 700 w. Eng News—March 3, 1910. No. 12110.

Wage Systems.

See same title, under INDUSTRIAL ECONOMY.

Waterproofing.

Waterproofing Masonry and Bridge Floors. Gives data from an appendix to the report of the Committee on Masonry of the Am. Main. of Way Assn. Ills. 4500 w. Eng Rec—March 26, 1910. No. 12664.

MATERIALS OF CONSTRUCTION.

Cement.

The Portland and Hydraulic Cement Industry (L'Industrie des Cimento Portland de Grappiers et Chaux Hydrauliques). H. Laborbe. A review of the industry and methods of manufacture in France. Ills. 15200 w. Mem Soc Ing Civ de France—Dec., 1909. No. 12406 G.

See also Sewer Pipe, under MUNICIPAL.

Concrete.

A Discussion of the Merits of Concrete for Shop Floors. Leonard C. Wason. Examines some of the claims and objections. 3500 w. Am Mach—Vol. 33. No. 13. No. 12773.

The Effect of Alkali on Concrete. Discussion of the paper by George Gray Anderson. 7500 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12709 E.

Tests Upon the Effect of Sea Water on Cement-Sand Mortar Briquettes. Cloyd M. Chapman. Read before the Nat. Assn. of Cement Users. Reports a series of experiments on the tensile strength of cement mortar immersed for various periods in sea water. 500 w. Eng News—March 10, 1910. No. 12219.

Further Tests on the Effect of Electrolysis on Concrete. O. L. Eltinge. An account of experiments in the electrical and testing laboratories of the Rensselaer Polytechnic Inst. Also editorial. Ills. 4200 w. Eng News—March 31, 1910. No. 12778.

Se also Aqueducts, under WATER SUPPLY.

Reinforced Concrete.

Tests of Reinforced Concrete Columns. Peter Gillespie. Read before the Nat. Assn. of Cement Users. Report of tests and statement of conclusions. 3000 w. Eng Rec—March 5, 1910. No. 12142.

Timber Preservation.

The Seasoning and Preservative Treatment of Wooden Cross-Ties. F. J. Angier. A discussion of methods and results, and of problems related. Also general discussion. 20000 w. Pro N Y R R Club—Feb. 18, 1910. No. 12316.

The Strength of Treated Timber. From the report of the Committee on Wood Preservation, at the annual meeting of the Am. Ry. Engng. & Main. of Way Assn. 1200 w. Eng News—March 24, 1910. No. 12584.

Tests of Creosoted Timber. W. B. Gregory. Gives report of tests, and comparison with untreated timber. Ills. 2500 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12656 E.

Preservative Treatment of Poles (Die Verfahren zu Konservierung hölzerner Leitungsmaste). E. F. Petritsch. Outlines preservatives, methods of treatment, and results. 7500 w. Elektrotech u Maschinenbau—Feb. 27, 1910. No. 12606 D.

MEASUREMENT.

Cement Testing.

Testing Cement by the Brinell Ball Method. A summary of facts from recent articles published in French technical papers. 1000 w. Engr, Lond—March 4, 1910. No. 12293 A.

Concrete Testing.

The Use of Beams on a Reduced Scale for Static Tests of Reinforced-Concrete Construction (Impiego delle Travi sperimentali in Scala ridotta per le Prove statiche delle Costruzioni in Cemento armato). Italo Vandone. A discussion of the utility of static tests on small concrete beams. Ills. Serial. 1st part. 3000 w. Monit Tech—Feb. 10, 1910. No. 12447 D.

Surveying.

The Organization of the Bureau of Surveys. E. J. Dauner. Describes the organization of the Bureau of Surveys for the city of Philadelphia. 3500 w. Pro Engrs' Club of Phila—Jan., 1910. No. 12567 D.

Marking the Alaskan Boundary. R. E. Robson. Describes methods and work of expeditions in 1908 on the Alsek River, and in 1909 on the 141st meridian in the White River region. Ills. 4000 w. Cal Jour of Tech—Feb., 1910. No. 12320.

Determination of the Meridian. C. E. Rowe. Describes the method of direct solar observation, the instruments, attachments and calculations. Ills. 3000 w. Mines & Min—March, 1910. No. 12085 C.

Air-Bubble Levels (Sur le Niveau à Bulle d'Air). Jules César. Outlines the sources of error and methods of evaluating errors. 1800 w. Bul Sci d l'Assn des Elèves—Jan., 1910. No. 12404 D.

Testing Methods.

See Fuel Testing, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

MUNICIPAL.

Asphalt Plants.

Municipal Asphalt Plant, Kansas City, Mo. Plan and illustrated description. 1500 w. Eng Rec—March 5, 1910. No. 12145.

Pavements.

Economics of Street Pavements. From report of Boston Finance Com. by Samuel Whinery. Compares different pavements on basis of cost. Considers factors of durability, and adapting pavement to traffic. 2200 w. Munic Jour & Engr—March 2, 1910. No. 12096.

Suggested Standard Specifications for Macadam, Brick, and Granite Block Pavement, and Concrete Pavement. Suggestions presented by committees appointed by a convention of city officials held at Chicago. 2500 w. Engng-Con—March 9 1910. Serial. 1st part. No. 12198.

Paving Block Inspection at the Manufacturing Plant. W. A. Aiken. Describes methods of inspection with the object of supplying good materials. 1500 w. Munic Engng—March, 1910. No. 12324 C.

Asphalt Block Paving in Toledo. F. I. Consaul. Gives the specifications for blocks and for laying and the improved methods. Ills. 2500 w. Munic Jour & Engr—March 2, 1910. No. 12097.

Brick Pavements in Ohio. Illustrates and describes work in various places. 8000 w. Munic Jour & Engr—March 2, 1910. No. 12095.

Roads.

State Road Work in New York in 1909. Reviews the report of the State Commission of Highways on the first year's operation of the new highway law of New York. 4000 w. Eng Rec—March 5, 1910. No. 12148.

Experimental Work of the New York State Highway Commission. An account of work to obtain data upon the cost and effectiveness of materials and methods. 2200 w. Eng Rec—March 12, 1910. No. 12246.

Effect of Motor and Horse-Drawn Vehicles on Roads. Logan Waller Page. Read at the Nat. Legislative Con. Discusses the problems that must be met by highway engineers. 2200 w. Eng Rec—Feb. 26, 1910. No. 12031.

Construction and Wear of Roads. Henry Reginald Arnulph Mallock, with abstract of discussion. Discusses foundations, surface, drainage, and formation and diffusion of dust. 20500 w. Inst of Civ Engrs, No. 3826—March 23, 1909. No. 12591 N.

Economics and Principles of Macadam Construction for Towns. D. T. Black. Discusses the serviceable qualities of macadam roads, their construction, and durability. 2500 w. Can Engr—March 4, 1910. No. 12133.

Macadam Roads and Their Preservation. L. W. Page. Discusses road construction and maintenance. General discussion. 12000 w. Jour W Soc of Engrs—Feb., 1910. No. 12557 D.

Tar Macadam and the New "Breining" Mixing Machine (Ueber Teermakadam und eine neue Teermakadammischmaschine, System "Breining"). Karl Breitenfelder. Discusses this road material and describes a new device for mixing and laying. Ills. 4500 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 19, 1910. No. 12488 D.

Notes on the Use and Cost of Concrete Blocks in Roadway Construction. George C. Wright. Read before the Nat. Assn. of Cement Users. Describes an experimental road built on this system, giving cost. 1000 w. Cement—March, 1910. No. 12671 C.

Dustless Roads. Report of the Royal Automobile Club. 2500 w. Surveyor—March 18, 1910. No. 12725 A.

Some Methods and Costs of Oiling Roads in St. Louis with a Description of a New Construction Employing Molded Slabs of Bitumen and Aggregate. Ills. 1800 w. Engng-Con—March 23, 1910. No. 12576.

Tar-Spraying Devices (Appareils à Goudronner). A. Moreau. A report on the Lassailly system, with details of the machine. Ills. 3000 w. Bul Soc d'Encour—Jan., 1910. No. 12417 G.

The Vinsonneau System of Tar Spraying (Le Système de Goudronnage des Routes par M. J. Vinsonneau). A. Moreau. Describes the machine and discusses the system. Ills. 2700 w. Bul Soc d'Encour—Jan., 1910. No. 12418 G.

We supply copies of these articles. See page 317.

Sanitation.

Progress of Sanitary Reform. H. T. Wakelam. Presidential address before the Institute of Sanitary Engineers on the advance of sanitation. Short discussion 5500 w. Surveyor—Feb. 25, 1910. No. 12183 A.

Sewage Disposal.

The Stumbling Block in Sewage Purification and the Means of Overcoming It (La Pierre d'Achoppement de l'Epuration des Eaux d'Egout et le Moyen de la Tourner). A. Puech. Discusses the difficulties in dealing with suspended matter in sewage and outlines various solutions of the problem. Ills. 6000 w. Bul Soc d'Encour—Jan., 1910. No. 12419 G.

Sewage Treatment to Prevent River Pollution. A statement by George A. Johnson at the convention of the Indiana Sew. & Water Sup. Assn. A discussion of sewage purification. 2500 w. Eng Rec—March 19, 1910. No. 12365.

Sewage of Ten Million Population. Kenneth Allen. Gives data collected by the New York Bay Pollution Commission concerning conditions attending the disposal of sewage in the metropolitan district. 2500 w. Munic Jour & Engr—March 23, 1910. Serial. 1st part. No. 12542.

The Drainage of a Country House. J. D. Watson. Read before the British Inst. of San. Engrs. Discusses the disposal of sewage from isolated buildings. Ills. 2500 w. Can Engr—March 25, 1910. Serial. 1st part. No. 12672.

Sewage Distribution.

Notes on the Automatic Revolving Sewage-Distributors at the Derby Sewage Disposal Works. Arthur Percy Maddocks. A report of tests. 3500 w. Inst of Civ Engrs, No. 3819—1909. No. 12595 N.

Sewage Distribution Tests at Mount Vernon, N. Y. Charles A. Hammond. An illustrated report of experiments to ascertain the actual discharge of various sizes of cylindrical nozzles, and the relative efficiency of spray distribution by various forms of splash-cups under different conditions. 2500 w. Eng News—March 24, 1910. No. 12583.

Sewage Testing.

The Sewage Testing Station of the Sanitary District of Chicago. Langdon Pearse. An account of the study of the sewage problem in Chicago to obtain data regarding the cheapest and best plan for increasing the present facilities for sewage development. Ills. 5000 w. Eng News—March 31, 1910. No. 12777.

Sewer Pipe.

Cement Pipe for Sewer Purposes. O. U. Miracle. Read before the N.-W. Cement Products Assn. Briefly discusses the principal objections raised, showing them to be groundless. 1200 w. Cement Age—March, 1910. No. 12543.

Sewers.

Some Points for Consideration in the Sewering of Small Towns. Henry C. Adams. Discusses the capacity of sewers, gradients, size of pipes and joints, tests, manholes, ventilation, etc. 3000 w. Surveyor—March 4, 1910. No. 12284 A.

A Large Storm Sewer Supported on Piers. A reinforced-concerte sewer in Philadelphia is illustrated and the construction described. 1300 w. Eng Rec—March 19, 1910. No. 12371.

See also Reinforced Concrete, under BRIDGES.

Snow Removal.

Method and Cost of Snow Removal in St. Louis, Mo., by Flushing It Through the City Sewers. Illustrated description. 900 w. Engng-Con—March 30, 1910. No. 12765.

Surveying.

See same title, under MEASUREMENT.

WATER SUPPLY.

Analysis.

The Sanitary Examination of Water. L. K. Russell, in the *Clarkson Bul.* Considers examinations necessary to insure a safe water for domestic use. 2500 w. Engng-Con—March 23, 1910. No. 12577.

Aqueducts.

The Grindleford to Rowsley Section of the Derwent Aqueduct. Alex. H. Jameson. Illustrated description of "Contract B," covering this portion of the work. Plate. 2200 w. Engr, Lond—March 4, 1910. No. 12292 A.

Concrete Arch Tests—Medina Aqueduct. Explains the necessity of constructing this aqueduct and the selection of a concrete arch of single span as the type, and describes extensive tests on concrete prisms and model arches for the purpose of obtaining information for this important work. Ills. 3500 w. Barge Canal Bul—Feb. 1910. No. 12317 N.

Tests of Models of the Medina Aqueduct Arch. From advance sheets of the *Barge Canal Bulletin.* An illustrated account of tests made to obtain information concerning the behavior of concrete under certain conditions of stress, in connection with the design of probably the most important piece of concrete arch construction yet undertaken. 3500 w. Eng Rec—March 5, 1910. No. 12140.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Columbus, O.

The Improved Water and Sewage Works of Columbus, Ohio. Discussion of the paper by John H. Gregory. 11000 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12710 E.

We supply copies of these articles. See page 317.

Dams.

Plans and Specifications for Early Timber, Earth and Masonry Dams Built in Connecticut. Illustrates and describes dams designed by Harry T. Potter, three built between 1860 and 1870, and nine built between 1881 and 1891, as described in a paper by C. E. Chandler, read before the Conn. Soc. of Civ. Engrs. 5000 w. Engng-Con—March 9, 1910. No. 12199.

Concrete and Masonry Dam-Construction in New South Wales. Leslie Augustus Burton Wade, with abstract of discussion. Illustrated detailed description of certain dams constructed for storing water. 48500 w. Inst of Civ Engrs, No. 3791—March 9, 1910. No. 12590 N.

Building the Olive Bridge Dam for the Catskill Water Supply. Illustrated description. 1500 w. Sci Am—March 19, 1910. No. 12348.

Description of the New Dam and Pumping Station Built by the City of Peterborough, Ont. A. W. Ellson Fawkes. Illustrated description of the work. 1600 w. Can Engr—March 4, 1910. No. 12132.

The Shut-Off Dam at the Charles River Basin. James W. Rollins, Jr. A critical discussion of the plans submitted, describing the design finally constructed. Ills. General discussion. 7500 w. Jour Assn of Engng Socs—Jan, 1910. No. 12570 C.

The Movable Dam Across the Red River at St. Andrew's Rapids. H. P. Borden. Explains the conditions and describes the solution of the problem by the construction of a Caméré curtain dam, the first constructed on the American continent. Ills. 5000 w. Eng Rec—March 26, 1910. No. 12660.

Partial Failure of a Concrete Dam at Austin, Pa. General plans and detailed description of the concrete dam for the Bayless Pulp & Paper Co., with an account of the trouble. 2500 w. Eng News—March 17, 1910. No. 12316.

Fishways (Ueber Anlage von Fischpässen). S. Bitterli. Discusses their design, illustrating types. 2200 w. Schweiz Bau—Feb. 12, 1910. No. 12476 B.

Diversion Damages.

The Underlying Principles Governing Riparian Water Rights and Diversion Suits. Charles F. Choate, Jr., with discussion. Explains the nature of the right the riparian owner possesses. 7000 w. Jour N Eng W-Wks Assn—March, 1910. No. 12597 F.

Report of Committee Appointed to Collect Data Relating to Awards for Water and Water-Power Diversion. Explains methods and value of data, the approximate power derivable from New England watersheds, and related information, with bibliography. 45000 w. Jour N Eng W-Wks Assn—March, 1910. No. 12596 F.

E. P. and S. Railway.

The Water Supply of the El Paso and Southwestern Railway from Carrzozo to Santa Rosa, N. Mex. J. L. Campbell. Describes the supply serving the division named, a distance of 128 miles. Ills. 7200 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12707 E.

Fire Protection.

Fire Wastes. Herbert M. Wilson. Discusses the enormous fire losses in the United States and its relation to the water supply. Discussion. 3500 w. Pro Am W-Wks Assn—1909. No. 12752 N.

Toronto High Pressure Fire System. C. L. Fellows. Illustrated description. 1200 w. Pro Am W-Wks Assn—1909. No. 12759 N.

The High Pressure Fire System of Baltimore. Raymond Schlegel. Describes the high pressure fire line under construction. 2000 w. Cornell Civ Engr—March, 1910. No. 12545 C.

Factories and Their Fire Protection. Franklin H. Wentworth. An illustrated article explaining certain fundamental principles to be kept in mind in planning a factory, and describing details. 2500 w. Archt Rec—March, 1910. No. 12021 C.

Ground Waters.

Observation and Investigation of Ground-Water Sources (Beobachtung und Ermittlung von Grundwasserständen und Strömungen). Rudolf Müller. Describes a simple device for investigation at depths of one or two metres beneath the surface. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 19, 1910. No. 12489 D.

The Computation of Ground Water Supplies (Contributo alla Teoria delle Falde idriche nei Terreni permeabili). Carl Fossa-Mancini. A mathematical discussion, including consideration of rainfall. Ills. 7000 w. Ann d Soc d Ing e d Arch Ital—Feb. 1, 1910. No. 12444 F.

Hydrants.

Progress Report of the Committee on Proposed Specifications for Post Hydrants. Discussion. 5500 w. Jour N Eng W-Wks Assn—March, 1910. No. 12598 F.

Irrigation.

Irrigation in Turkey (L'Irrigation en Turquie). Louis Godard. A review of the irrigation projects of the Turkish government. Ills. 4000 w. Génie Civil—Feb. 12, 1910. No. 12439 D.

Liverpool.

Completion of Liverpool Water-Works at Vyrnwy. First article of a series describing in detail the great Welsh water scheme for the supply of Liverpool. Ills. 1200 w. Engr, Lond—March 18, 1910. Serial. 1st part. No. 12741 A.

Mexico.

Water Problems in Mexico. Edward Bartow. An illustrated explanation of

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conditions and the work accomplished. 1200 w. Pro Am W-Wks Assn—1909. No. 12760 N.

Pipe Corrosion.

Action of St. Louis Water on Metals and Alloys. Abstract of a paper by W. F. Monfort before the Illinois Water Supply Assn. describing the action of chemically treated water upon the metal of the distribution system. 3000 w. Eng Rec—March 19, 1910. No. 12366.

Pipe Failures.

A Break in a Water Main at Springfield, Mass. Elbert E. Lochridge. Brief account of the accident and its consequences. 700 w. Eng News—March 31, 1910. No. 12781.

Purification.

The Development of the Water Supply at Superior, Wisconsin, with Special Reference to the Iron Removal Plant Now in Operation. William C. Lounsbury. An illustrated account of the water supply of Superior. 3000 w. Pro Am W-Wks Assn 1909. No. 12754 N.

Reforestation.

Reforestation of the Marginal Lands of the Wachusett Reservoir of the Metropolitan Water Works, Boston, Mass. E. R. B. Allardice. Outlines the general plan adopted and describes the work of raising from seed the trees to be used in the field and the improvement and protection on existing forests. Ills. Discussion. 10000 w. Jour Assn of Engng Socs—Jan, 1910. No. 12572 C.

Reservoirs.

See Roofs, under CONSTRUCTION; and Reforestation, under WATER SUPPLY.

Tanks.

A Water Tank with a Dome Supported Bottom. Brief illustrated description of a novel tank recently built in Mexico. It is of reinforced concrete carried on a circular rubble wall with a novel type of floor construction. 1000 w. Eng Rec—Feb. 26, 1910. No. 12029.

Some Methods and Cost of Building Reinforced Concrete Cisterns. Benjamin Brooks. Plan and description of reinforced-concrete cisterns for water storage, San Francisco, Cal. 2500 w. Engng-Con—March 30, 1910. No. 12766.

Wastes.

Waste Water Survey, City of Chicago. T. C. Phillips. Explains the methods of investigation. Discussion. 7500 w. Pro Am W-Wks Assn—1909. No. 12751 N.

Water Towers.

A Concrete Water Tower. A. Kempkey, Jr. Illustrated description of an elevated tank of novel design for the water works system of the city of Victoria, B. C., with the reasons for adopting the type of structure used, the method of construction and cost. 3000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12653 E.

Water Works.

Braintree Water-Works Extension. Brief description of the work completed in connection with an important scheme of extensions. The deepening of an old well and the installation of new pumping machinery. 1500 w. Eng., Lond—Feb. 25, 1910. No. 12195 A.

Water-Works Valuation.

The Necessary Elements for Water-Works Valuation. John W. Alford. Read before the Indiana San. & Water-Suply Assn. Outlines four methods of valuing public utility property which have been upheld by the courts, and discusses in detail the valuation by reproduction. 2500 w. Eng News—March 10, 1910. No. 12217.

Notes on Going Value and Methods for Its Computation. John W. Alvord. Discusses the theory of valuation by reproduction. General discussion follows. 32600 w. Pro Am W-Wks Assn—1909. No. 12753 N.

Weirs.

A New Type of Weir Construction (Das Kragnadelwehr). Otto Felix Schossberger. A detailed mathematical discussion of the design of a new type of needle weir. Ills. Serial. 1st part. 5000 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 5, 1910. No. 12487 D.

WATERWAYS AND HARBORS.

Barge Canal.

Rapid Progress of the New York State Barge Canal. Illustrated report of recent work. 800 w. Sci Am—March 5, 1910. No. 12069.

Bulkheads.

The Sea Wall in Connection with Buildings. George A. Orrok. Read before the Conn. Soc. of Civ. Engrs. Describes a number of bulkhead constructions that have been used with success, stating difficulties encountered and approximate costs. Ills. 2200 w. Eng Rec—Feb. 26, 1910. No. 12032.

Canal Regulators.

Collapse of an Important Canal Head Sluice in Egypt. Sir Hanbury Brown. Illustrated account of the wreck of the Menufia head regulator on Dec. 26, 1909. 2500 w. Engr, Lond—March 18, 1910. No. 12738 A.

Canals.

See Barge Canal, under WATERWAYS AND HARBORS.

Dredges.

Clay-Cutting Suction Dredger for Auckland, N. Z. Illustrated description of a recently built pontoon suction dredge for deepening Auckland harbor and reclaiming land at that port. 500 w. Engr, Lond—March 11, 1910. No. 12503 A.

See also Dredging, under ELECTRICAL ENGINEERING, POWER APPLICATION.

We supply copies of these articles. See page 317.

Flood Protection.

The Protection and Drainage of Lands Subject to Overflow. Notes from a paper by C. W. Brown before the Ills. Soc. of Engrs. & Survs. Discusses the design and construction of such works. 3300 w. Eng Rec—Feb. 26, 1910. No. 12033.

Floods.

The Engineering Features of the Recent Floods in Paris. Explains conditions that caused the floods, giving a record of the height in Paris and the damage. Ills. 4500 w. Eng News—March 24, 1910. No. 12582.

The Seine Flood of January, 1910 (La Crue de la Seine, de Janvier, 1910). A. Dumas. A review of the history of the flood, profusely illustrated. 9000 w. Génie Civil—Feb. 5, 1910. No. 12436 D.

Fighting the Paris Flood. Warren H. Miller. Describes the floor, the problems to be met, and the methods used in solving them. Ills. 3000 w. Eng Rec—Feb. 26, 1910. No. 12025.

Cause and Remedies of the Seine Floods (Les grandes Crues de la Seine, Causes et Remèdes). C. Boutillier. A study of the problems presented by the recent flood. 5000 w. Tech Mod—Feb., 1910. No. 12426 D.

France.

The Inland Waterways Propaganda in France. Explains how the waterways development was brought about, and the attitude of the government. 2000 w. Eng News—March 24, 1910. No. 12587.

Locks.

The Locks and Gates of the Panama Canal. Map and plate with illustrated description of the structures and explanation of the principles governing their design. 6500 w. Eng Rec—Feb. 26, 1910. No. 12024.

Panama Canal.

The Real Status of the Panama Canal as Regards Neutralization. H. S. Knapp. Discussion regarding freedom of passage and inviolability in war, stating facts and conclusions favoring its being fortified and garrisoned. 15800 w. Pro U S Nav Inst—March, 1910. No. 12537 F.

See also Locks, under WATERWAYS AND HARBORS.

Piers.

The Chelsea Section Improvement—A Municipal Enterprise. Illustrated description of the mine piers extending from Little West Twelfth Street to West Twenty-second Street, on the North River, New York City. A bulkhead wall of concrete and masonry, pier sheds, and their equipment. 1500 w. Archts & Bldrs' Mag—Feb., 1910. No. 12210 C.

Structural Features of New Concrete Recreation Pier at Albany, N. Y. Illustrated description of a new recreation and boat pier being constructed after designs by Walter Melius. 700 w. Engng-Con—March 23, 1910. No. 12574.

Pollution.

See Coke-Oven Effluents, under MINING AND METALLURGY, COAL AND COKE.

River Regulation.

Regulation of the Lower Elbe from Hamburg to Brunshausen (Regulierung der Unterelbe von Hamburg bis Brunshausen). A. v. Horn. Describes methods, cost, etc. Ills. 6500 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 26, 1910. No. 12490 D.

Sea-Water Freshening.

Distribution of Sea Water in the Charles River Basin After Excluding Tidal Waters. Morton F. Sanborn. Investigations to determine the rate of freshening and study of the circulation are described. 2500 w. Eng News—March 10, 1910. No. 12214.

Stream Flow.

The Relation of Forests to Stream Flow. Maj. William W. Harts. From Prof. Mem., Engrs.' Bureau, U. S. Army. Reports a study of the Cumberland and the Tennessee rivers which refutes statements regarding deforestation and navigation. Also a letter from R. C. Beardsley and editorial. 6500 w. Eng News—March 3, 1910. No. 12109.

U. S. Waterways.

Light from Europe on Proposed Waterway Development in the United States. Editorial on the report by W. H. Lindley dealing with European waterways, comparing with report regarding the Mississippi and its tributaries. 1800 w. Ry Age Gaz—March 25, 1910. No. 12639.

Water Powers.

The Evaluation of Water Rights. Arthur Halsted. Gives a method of evaluating a water right which is applicable to a special case of an undeveloped, or partially developed water power. 3000 w. Eng Rec—Feb. 26, 1910. No. 12028.

MISCELLANY.

Caisson Disease.

Caisson Disease. Editorial on an investigation of the Admiralty Committee. 2200 w. Engng—Feb. 18, 1910. No. 12063 A.

U. S. Reclamation Service.

Extracts from the Testimony of Arthur P. Davis, Chief Engineer of the U. S. Reclamation Service, before the Committee to Investigate the Interior Department and Forestry Service. 3500 w. Eng News—March 31, 1910. No. 12780.

Wood Refuse.

An Important Development in the Utilization of Wood Refuse. Walter E. Truesdell. Describes a plant being built at Hadlock, Washington, for producing ethyl alcohol on a commercial scale, and explains use of the residue. 2500 w. Cornell Civ Engr—March, 1910. No. 12546 C.

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ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

Wireless Telegraphy and Telephony. Cornelius D. Ehret. A review dealing only with wireless telegraphy and wireless telephony employing electro-magnetic waves. Short discussion. 6500 w. Pro Engrs' Club of Phila—Jan., 1910. No. 12565 D.

The Radiation from Directive Aerials in Wireless Telegraphy. L. H. Walter. Deals with the question of dirigibility in the emission of electric waves, taking into account the methods of Artom, and of Bellini and Tosi. 2000 w. Elect'n, Lond—Feb. 25, 1910. No. 12177 A.

Joint Navy and Fessenden Long-Distance Wireless Tests. An account of tests made and to be made in the interest of the U. S. Navy Department, especially with the Fessenden apparatus. 2000 w. Elec Wld—March 31, 1910. No. 12628.

Radiotelephony.

The Collins Long-Distance Wireless Telephone. William Dubilier. Illustrated detailed description. 1000 w. Elect'n, Lond—March 4, 1910. No. 12281 A.

See also Radiotelegraphy, under COMMUNICATION.

Telephony.

The Early Days of the Telephone. Facts from the testimony of Theodore N. Vail before a joint committee of the N. Y. State Legislature. 6500 w. Elec Rev, N Y—March 5, 1910. No. 12163.

Telephone Circuits. Prof. J. Perry. Abstract of a paper before the Physical Society, with remarks of interest by Major O'Meara and A. W. Martin in connection with the Post-Office telephone cables. 4500 w. Elect'n, Lond—March 11, 1910. No. 12330 A.

Telephotography.

The Sémat System of Telephotography (Le Téléautocopiste Sémat). M. de Kermond. Illustrated description. 2000 w. L'Elecn—Feb. 5, 1910. No. 12427 D.

DISTRIBUTION.

Condensers.

Tubular Electric Condensers. A. D. Budd. Illustrates and describes a process of producing condensers from paper, soaked with a well-adhering insulating varnish. 1200 w. Elec Wld—March 24, 1910. No. 12580.

Fuses.

An Investigation of the Fusing of Silver, Copper, and Lead Wires in Porcelain Tube Cartridges (Abschmelzversuche mit Silberdrähten, Kupferdrähten und Bleidrähten in Porzellan-Rohrpatronen). Robert Edler and Robert Schuster. Describes the tests and reports results. Ills. Serial· 1st part. 2000 w. Elektrotechniker —Feb. 10, 1910. No. 12497 D.

DYNAMOS AND MOTORS.

A. C. Dynamos.

The Design of Turbo Field Magnets for Alternate-Current Generators with Special Reference to Large Units at High Speeds. Miles Walker. Re-opens the controversy between the salient pole type and the cylindrical type, giving reasons why the latter is better suited for obtaining the greatest possible output from a given diameter. Ills. 3500 w. Inst of Elec Engrs—March 10, 1910. No. 12716 N.

Armature Reaction and Compounding of Alternators. J. E. Dalemont and L. A. Herdt. Discusses the causes of drop in alternators, and explains two methods of compensation. 2200 w. Elect'n, Lond—March 11, 1910. No. 12331 A.

Short-Circuiting of Large Electric Generators and the Resulting Forces on Armature Windings. Miles Walker. Deals with the currents which flow when large electric generators are short-circuited. Ills. 5000 w. Inst of Elec Engrs—March 8, 1910. No. 12328 N.

Voltage Regulation of Alternators. Burton McCollum. Explains methods of determining the regulation of an alternator. 3300 w. Bul Univ of Kansas, No. 1—Nov., 1909. No. 12650 N.

A. C. Motors.

Discussion on "On the Space Economy of the Single-Phase Series Motor," New York, January 14, 1910. Discussion of paper by William S. Franklin and Stanley S. Leyfert. 5000 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12705 F.

Commutation.

Commutation. F. W. Carter. A discussion of resistance and reactance of coil circuits during the commutating period. Also editorial note. 3000 w. Elec Wld—March 31, 1910. No. 12627.

Failures.

Lessons of Some Motor and Dynamo Failures. Howard S. Knowlton. Explains causes of trouble. 1800 w. Power —March 8, 1910. No. 12171.

Heating.

The Influence of Ventilation on the Temperature of Bare or Insulated Conductors (De l'Influence de la Ventilation sur la Température de Régime des Conducteurs nus ou isolés). Louis Roy. Mathematical discussion. 4000 w. Bul Soc Int d'Elecns—Feb., 1910. No. 12410 F.

Induction Motors.

The Operation of Single-Phase Induc-

We supply copies of these articles. See page 317.

tion Motors (Die Wirkungsweise des einphasigen Induktionsmotors). Gustav Benischke. Mathematical discussion of induction-motor characteristics. Ills. 3200 w. Elec Kraft u Bahnen—Feb. 4, 1910. No. 12499 D.

Motor Converters.

The Cascade Converter (Der Kaskadenumformer). H. S. Hallo. A practical discussion of its operation. Ills. 4000 w. Elek Kraft u Bahnen—Feb. 14, 1910. No. 12600 D.

Motor Generators.

Motor-Generator Sets of 3000 Kilowatts Maximum Continuous Rating. David Hall. Illustrated descriptions of recent designs. 1200 w. Elec Jour—March, 1910. No. 12314.

Speed Regulation.

The Routin Automatic Governor for Alternators, Turbines, etc. (Régulateurs automatiques, système J. L. Routin applicables aux Alternateurs, Turbines, etc.). Illustrated description of the governor and its application. 2500 w. L'Elecn—Feb. 26, 1910. No. 12431 D.

A New System of Governing Three-Phase Motors and a Comparison with Systems Hitherto Used (Ein neues System regelbarer Drehstrommotoren und ein Vergleich desselben mit bisher angewandten Systemen zum Regeln der Umlaufzahl elektrischer Motoren). A. Scherbius. Detailed description. Ills. Serial. 1st part. 2600 w. Elek Kraft u Bahnen—Feb. 24, 1910. No. 12602 D.

Standardization.

Some Notes on Standardization of Electrical Machines. R. Orsettich. Discusses the arrangements generally adopted in the manufacture of dynamo-electric machinery. 4500 w. Elect'n, Lond—March 11, 1910. No. 12329 A.

Stray Currents.

The Genesis and Avoidance of Stray Currents in Machine Frames (Entstehung und Vermeidung von Lagerströmen). Leonhard Adler. Discusses their cause and means for avoiding currents through the axle, bearings and base plates of electrical machines. Ills. 4100 w. Elektrotech u Maschinenbau—Feb. 20, 1910. No. 12624 D.

ELECTRO-CHEMISTRY.

Cells.

On Cadmium Amalgams and the Weston Normal Cell. F. E. Smith. Abstract of a paper read before the Physical Soc. Describes researches with chilled and slowly cooled amalgams containing from 1 to 25 per cent of cadmium. 3500 w. Elect'n, Lond—March 18, 1910. No. 12720 A.

Corrosion.

See Boiler Corrosion, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Electric Furnaces.

The Proportioning of Electrodes for Furnaces. Carl Hering. A study of the principles underlying the proper proportioning of electrodes. A review of investigations. 15000 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12703 F.

Properties and Behavior of Furnace Electrodes. Carl Hering. Examines, by analogy, the changes in the behavior of the electrodes caused by the different physical properties and temperature variations. 3000 w. Met & Chem Engng—March, 1910. No. 12205 C.

On the Modifications in Hering's Laws of Furnace Electrodes Introduced by Including Variations in Electric and Thermal Resistivity. A. E. Kennelly. Considers, from an arithmetical point of view, how far the temperature variation in electric and thermal resistivities of the electrodes modifies these laws. 3000 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12702 F.

Electroplating.

The Management and Analysis of Silver Plating Solutions in Germany; and the Use of Barium Cyanide for Their Regeneration. B. Wenzelmann. Directions to enable the silver plater to control and analyze his cyanide silver solutions without the assistance of a chemist. 2000 w. Brass Wld—March, 1910. No. 12541.

Nitrogen.

The Reduction of Atmospheric Nitrogen. Illustrates and describes the Schönherr process. 1200 w. Sci Am Sup—March 12, 1910. No. 12225.

Ozone.

The Uses of Ozone: The Ozonair System. Illustrates and describes the portable ozone generators and the system developed by E. L. Joseph. 1000 w. Elec Rev, Lond—March 18, 1910. No. 12715 A.

Review of 1909.

Electrochemistry and Electrometallurgy in 1909. Dr. F. Mollwo Perkin. A review of progress. 6000 w. Elect'n, Lond—March 18, 1910. No. 12719 A.

ELECTRO-PHYSICS.

Conservation of Energy.

The Law of Conservation of Energy. Dr. Charles P. Steinmetz. Calls attention to the uses of this law for engineering purposes. 4500 w. Jour W. Soc of Engrs—Feb., 1910. No. 12558 D.

Current Rectifiers.

Crystal and Solid Contact Rectifiers. A. E. Flowers. Abstract of an article in the *Phys. Rev.* Describes the characteristics of the galena rectifier, and the artificial production of rectifiers by chemical and electrochemical treatment, discussing results. 1800 w. Elect'n, Lond—Feb. 18, 1910. No. 12055 A.

See also Oscillograph, under MEASUREMENT.

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Electric Waves.

Electric Waves and the Electromagnetic Theory of Light. Abstract of the first three lectures given by Prof. Sir Joseph J. Thomson at the Royal Institution. 2500 w. Elect'n, Lond—March 4, 1910. Serial. 1st part. No. 12280 A.

Electric Waves and the Electromagnetic Theory of Light. Editorial review of Sir J. J. Thomson's lecture on this subject. 2500 w. Engng—March 18, 1910. No. 12735 A.

Production, Measurement, and Effect of Variable Wave-Form. Lancelot W. Wild. Communicated to the Inst. of Elec. Engrs. Describes the author's means of varying the wave-form, and for measuring its characteristics, giving results of tests. 7500 w. Elec Engr, Lond—Feb. 18, 1910. No. 12050 A.

Hysteresis.

Effect of Temperature on the Hysteresis Loss in Iron in a Rotating Field. W. P. Fuller and H. Grace. Abstract of paper read before the Phys. Soc. A report of experimental investigations. 700 w. Elect'n, Lond—Feb. 25, 1910. No. 12179 A.

Induction.

On the Law of Induction (Sur la Loi de l'Induction). M. de Baillehache. A comprehensive theoretical discussion. Ills. 13000 w. Bul Soc Int d'Elecns—Feb., 1910. No. 12412 F.

Induction Coils.

Teaching the Theory of an Alterating-Current Circuit Surrounding an Iron Core (Pädagogisches zur Theorie des eisenumschlingenden Wechselstromkreises). Carl Breitfeld. Discusses the best method of teaching the theory of cyclic magnetization. Ills. 2800 w. Elektrotech u Maschinenbau—Feb. 6, 1910. No. 12625 D.

Magnetic Properties.

The Magnetic and Electrical Properties of Iron—Silicon Alloys. Charles F. Burgess and James Aston. Reports an investigation covering tests of 15 iron-silicon alloys, discussing results. 1000 w. Met & Chem Engng—March, 1910. No. 12206 C.

GENERATING STATIONS.

Balancers.

Balancers for Three-Wire Systems. A. G. Cooper. Abstract of a paper before the Manchester Sec. of the Inst. of Elec. Engrs. Describes the well known forms of continuous-current balancers and also discusses static balancers, giving particulars of some tests. General discussion. 2200 w. Elect'n, Lond—Feb. 25, 1910. No. 12178 A.

Central Stations.

Central Stations for Towns of 1000 Population. Caryl D. Haskins. Information as to cost of installations and operations of electrical plants for towns from 500 people, upward. 3500 w. Munic Engng—March, 1910. No. 12327 C.

Electrical Plant of the Hudson and Manhattan Railroad Company. Illustrates and describes the generating and distributing systems of the McAdoo Hudson River tunnels. 1200 w. Elec Wld—March 3, 1910. No. 12102.

Power Station of the Hudson & Manhattan Railroad. Hugh Hazelton. Illustrated detailed description, with editorial. 4000 w. Elec Ry Jour—March 5, 1910. No. 12134.

Merchants Heat and Light Company. Illustrated description of the application of the steam turbine for lighting and exhaust steam heating at Indianapolis, Ind. 1500 w. Elec Wld—March 17, 1910. No. 12376.

New Power Plant of the Merchants Heat and Light Company, Indianapolis. Illustrated description of a modern central station. 3000 w. Elec Rev, N Y—March 5, 1910. No. 12162.

New High-Tension Electric Generating Station, Dundee. Illustrated detailed description of the station furnishing power for this city in Scotland. 4000 w. Engng—March 18, 1910. No. 12731 A.

The Electrical Plants of the Hannover Street Railways (Die elektrischen Anlagen der Strassenbahn Hannover, insbesondere deren Betrieb als Ueberlandzentrale). B. Urbach. Details of the five generating stations and the four substations. Ills. Serial. 1st part. 2500 w. Elek Kraft u Bahnen—Feb. 14, 1910. No. 12601 D.

Costs.

Cost of Production in Four Central Stations. Gives detailed records of cost for four properties in Massachusetts. 1200 w. Elec Wld—March 31, 1910. No. 12769.

The Consumption of Coal per Kilowatt-Hour in Central Stations (Le Centrali termoelettriche ed il Consumo di Carbone per kw.-Ora). Guiseppe Belluzzo. A discussion of the importance of the fuel item in the cost of electric power. Ills. 3700 w. Industria—Feb. 20, 1910. No. 12450 D.

Economics.

Ice Making and Steam Heating by Small Central Station. Detailed analysis of the methods employed to obtain the maximum return on the investment. Ills. 2500 w. Elec Wld—March 3, 1910. No. 12103.

Central Station Economies. W. L. Abbott. Reviews the progress in methods of generating and distributing electrical energy, and considers the important economies. Discussion. 7500 w. Jour W Soc of Engrs—Feb., 1910. No. 12556 D.

Hydro-Electric.

A General Review of Hydroelectric-Engineering Practice. Frank Koester. Dis-

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cusses the economic and engineering aspects of the impounding of water powers. First article of a series. Ills. 5000 w. Engineering Magazine—April, 1910. No. 12683 B.

Operations of Hydroelectric Plants. Alton D. Adams. Discusses the advantages attending the storage of water for use as needed. 1400 w. Elec Wld—March 24, 1910. No. 12579.

Electric Power Development on the Los Angeles Water-Supply Aqueduct. Gives the findings reported by the Board of Consulting Engineers as the result of a preliminary study. Map. 3000 w. Eng News—March 24, 1910. No. 12585.

Hydroelectric Plant, with Storage. R. A. Lundquist. Illustrated description of a 46000-volt system of the La Crosse, Wis., Water-Power Co. 3000 w. Elec Wld—March 31, 1910. No. 12626.

The Nisqually Hydro-Electric Plant of the City of Tacoma, Washington. Plans and description of a $2,000,000 municipal power plant. 1500 w. Eng News—March 17, 1910. No. 12307.

The Construction of the Rainbow Falls Hydroelectric Development. Illustrated description of this development on the Missouri River, near Great Falls, Montana. 6000 w. Eng Rec—March 12, 1910. No. 12230.

Distribution System of the Southern Power Company. J. W. Fraser. An illustrated article giving a summary of generating stations, substations, and transmission lines, with a description of recent 100,000-volt work. 1500 w. Elec Wld—March 24, 1910. No. 12578.

The Bear River Plant of the Telluride Power Company. Outlines the system of this company, giving an illustrated detailed description of the development near Grace, Idaho. 3500 w. Eng Rec—March 26, 1910. No. 12661.

The Mexico Light & Power Co.'s Electric Plant. H. E. West. Illustrated detailed description of the Necaxa plant. 3000 w. Min Wld—March 5, 1910. No. 12159.

The Refrain Power Plant (L'Usine du Refrain). Illustrated description of an important plant in Switzerland. Serial. 1st part. 500 w. Bul Tech d l Suisse Romande—Feb. 10, 1910. No. 12424 D.

Madrid.

The Electrical Industries in Madrid (Las Industrias electricas en Madrid). Severo Gomez Nunez. A brief review of the generating stations in Madrid. Serial. 1st part. 2800 w. Energia Elec—Feb. 10, 1910. No. 12451 D.

Power Factor.

Power Factor Correction. Shows the cause of phase displacement between the current and pressure and the detrimental effects upon the working of the plant, discussing what can be done to correct the trouble. 4400 w. Engr, Lond—Feb. 25, 1910. Serial. 1st part. No. 12193 A.

Protective Devices.

The Protection of Electrical Plants Against Dangerous Rises of Tension (La Protezione degli Impianti elettrici contro le Sopratensioni pericolose per il Pubblico). Vittorio Barassi. Discusses causes of, and methods of protection against, sudden rises of voltage. Ills. Serial. 1st part. 2500 w. Industria—Feb. 6, 1910. No. 12449 D.

Rates.

British Central-Station Rates. Francis H. Davies. Brief account of the different systems of charging and the movement toward standardization in method of charge. 2000 w. Elec Wld—March 10, 1910. No. 12202.

"Reasonable Rates" for Gas and Electricity as Determined by the Wisconsin Railroad Commission for the City of Madison. Gives the method of valuation and related investigations. 5000 w. Eng News—March 31, 1910. No. 12779.

Commercial Motor Service Rates and Their Effect on Station Economy. A. E. Walden. Suggestions on the development of the business prospects of motor service, the type of motor, the question of rating, etc. 2500 w. Elec Wld—March 3, 1910. No. 12104.

Taxes.

Taxes on Electricity (Steuer auf Elektrizität). Heinrich Schreiber. A criticism of recent legislation in Germany and Austria. 6000 w. Elektrotech u Maschinenbau—Feb. 13, 1910. No. 12604 D.

LIGHTING.

Arc Lamps.

The Stave Flaming Arc Lamp. Illustrated description of one of the new high efficiency lights of alternating-current type. 1500 w. Ir Age—March 31, 1910. No. 12784.

Illumination.

Graphical Method of Solving Certain Problems in Illuminating Engineering. Albert F. Parks. Gives diagram and chart with explanation. 1500 w. Elec Wld—March 24, 1910. No. 12581.

Quality of Light. Paul F. Bauder. A study of illumination concluding that the best artificial illuminant is that which is adaptable to the largest number of classes of service, providing its quality is maintained. 4000 w. Jour Fr Inst—March, 1910. No. 12750 D.

Electricity in a Modern Restaurant. T. I. Jones. Illustrates and describes the applications of electricity for illumination and power in the Café de l'Opera, New York. 2000 w. Elec Wld—March 10, 1910. No. 12200.

Incandescent Lamps.

The Electric Incandescent Lamp. James

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Findlay. Read at the Birmingham and District Elec. Club. Deals with its construction and application. 4000 w. Elec Engr, Lond—Feb. 25, 1910. No. 12176 A.

Tantalum Filament Characteristics. L. Crouch. Develops a simplified Stefan formula. 700 w. Elect'n, Lond—Feb. 25, 1910. No. 12180 A.

The Tungsten Lamp and Its Relations to Central Stations. George Merrill. Showing the effect of the tungsten lamp and its later developments upon commercial interests. 2500 w. Munic Engng—March, 1910. No. 12326 C.

Metallic-Filament Incandescent Lamps (Les Lampes incandescentes à Filament Métallique). A. Joubert. A review of their development, manufacture, applications, and economy. Ills. 5500 w. L'Elecn—Feb. 19, 1910. No. 12430 D.

Luminous Efficiency.

Luminosity and Temperature. P. G. Nutting. Investigations of the relation of luminous efficiency to temperature. 2000 w. Bul Bureau of Stand—Feb., 1910. No. 12561 N.

Luminous Efficiency of the Firefly. H. E. Ives and W. W. Coblentz. An investigation of the quality of the light emitted by the firefly, and of a fluorescent substance from the firefly. 4000 w. Bul Bureau of Stand—Feb., 1910. No. 12560 N.

Selective Radiation from Various Solids—II. W. W. Coblentz. Records the behavior of representative examples of various groups of chemical compounds. A study of the radiation from minerals and from metals. 4000 w. Bul Bureau of Stand—Feb., 1910. No. 12559 N.

Mercury Vapor.

Quartz-Tube Mercury-Vapor Lamps. Warren H. Miller. Describes one of these lamps installed in Paris, explaining the operation and giving information. Ills. 1500 w. Elec Wld—March 17, 1910. No. 12378.

The Applications of the Mercury Vapor Lamp (Les Applications de la Lampe à Vapeur de Mercure). A. R. Garnier. Discusses its application to lighting, the production of high-frequency currents, the separation of alternating currents, etc. Ills. Serial. 1st part. 1800 w. L'Elecn—Feb. 26, 1910. No. 12432 D.

Train Lighting.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

MEASUREMENT.

Galvanometers.

A Theoretical and Experimental Study of the Vibration Galvanometer. Frank Wenner. Mathematical. 8000 w. Bul Bureau of Stand—Feb., 1910. No. 12562 N.

Hysteresis Loss.

A Ballistic Electrodynamometer Method of Measuring Hysteresis Loss in Iron. Martin E. Rice and Burton McCollum. Presents a new and accurate method for making tests to predetermine the hysteresis losses in iron. 2500 w. Bul Univ of Kansas, No. 1—Nov., 1909. No. 12599 N.

Instruments.

Alternating-Current Measuring Instruments, with Special Reference to the New Weston Electromagnetic Type. B. A. J. van der Hegge Zijnen. Discusses their theory, design and use. Ills. 12000 w. De Ingenieur—Feb. 19, 1910. No. 12619 D.

Ferrié and Charpentier Two-Pointer Frequency Meters and Ohmmeters (Appareils à deux Aiguilles, Système Ferrié et Charpentier. Fréquencemètres. Ohmmètres). L. Joly. Describes the construction of the instruments and explains their theory. Ills. 3000 w. Bul Soc Int d'Elecns—Feb., 1910. No. 12411 F.

Laboratories.

The Equipment of the Electrical Engineering Laboratories at the Brighton Technical College. H. H. Broughton. Illustrates and describes the machinery installed. 3000 w. Elec'n, Lond—March 4, 1910. No. 12279 A.

The Palmer Physical Laboratory. Howard McClenahan. Illustrated description of the electrical equipment of the building devoted to the use of the departments of physics and electrical engineering at Princeton University. 2200 w. Elec Wld—March 17, 1910. No. 12377.

Motor Testing.

Short-Circuit Tests of Direct-Current Machines (Kurzschlussdauerproben von Gleichstrommaschinen). R. Doczekal. Practical discussion of testing methods. Ills. Serial. 1st part. 2500 w. Elektrotech u Maschinenbau—Feb. 27, 1910. No. 12607 D.

Oscillograph.

Application of the Oscillograph in Studying the Operation of Mercury Rectifiers. Yasudiro Sakai. An explanation of its usefulness in such study. Diagrams. 2500 w. Elec Jour—March, 1910. No. 12315.

Permeability.

Note on the Use of Kapp's Apparatus for Measuring Permeability of Iron under High Magnetizing Forces. R. Beattie and H. Gerrard. Describes experiments, showing that results do not support those of E. A. Watson. 1800 w. Elect'n, Lond—Feb. 18, 1910. No. 12054 A.

Wave Form.

The Production, Measurement and Effect of Variable Wave-Form. Lancelot W. Wild. Abstract of a communication to Inst. of Elec. Engrs. Describes the

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apparatus used for obtaining various wave-forms, and the methods adopted. Also gives tests. 3000 w. Elect'n, Lond —March 14, 1910. No. 12278 A.

POWER APPLICATIONS.

Dredging.

Electricity in Dredging on Puget Sound. Allen E. Ransom. Illustrated description of the electrically driven suction dredge named the "Washington" and its work in the Puyallus River. 1400 w. Elec Jour—March, 1910. No. 12312.

TRANSMISSION.

Balancers.

See same title, under GENERATING STATIONS.

Conduits.

Electrical Conduit Construction. Illustrates and describes examples of recent practice. 1500 w. Elec Rev, N Y—March 26, 1910. No. 12669.

Underground Conduit. Paul W. England. Brief description of early forms laid in Philadelphia, and the changes in construction methods from time to time. Present practice and special cases are described in detail. Ills. Short discussion. 6500 w. Pro Engrs' Club of Phila—Jan., 1910. No. 12566 D.

High Tension.

See Hydro-Electric, under GENERATING STATIONS.

Insulators.

See Protective Devises, under TRANSMISSION.

Lightning Protection.

Elan Valley Works: Protection from Lightning. Sir Oliver Lodge. Reports on examination of water-works to determine possible danger from lightning and how best to ensure protection. 3500 w. Elec Engr, Lond—March 4, 1910. No. 12277 A.

See also Signalling, under RAILWAY ENGINEERING, CONDUCTING TRANSPORTATION.

Line Design.

Economics of Feeder Calculation. H. B. Gear. Method of determining the probable annual loss, based on an analysis of the load curves, and on the development of a formula. 4000 w. Elec Age—March, 1910. No. 12680.

Poles.

See Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Protective Devices.

A Practical Method of Protecting Insulators from Lightning and Power Arc Effects. L. C. Nicholson. Relates the experiences and experiments leading to the protective measures adopted on the 6000-volt transmission line of the Niagara, Lockport and Ontario Power Co. from Niagara Falls to Syracuse and other cities. Ills. 5500 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12701 F.

Transformers.

Special Transformers. Norman G. Meade. Discusses briefly three-phase transformers, constant-current transformers and potential regulators. 800 w. Power—March 29, 1910. No. 12746.

Large Artificially Cooled Transformers. Edwin R. Pearson. Describes recent developments in the design and manufacture of transformers of this type. 2500 w. Elec Wld—March 10, 1910. No. 12201.

Voltage Regulation of Stationary Transformers. E. H. Acton. Derives formulas for calculating regulation, showing that in general commercial designs the regulation is practically independent of the exciting current. 1200 w. Elec Wld —March 17, 1910. No. 12379.

MISCELLANY.

Electric Clocks.

Modern Electric Time Service. F. Hope-Jones. Abstract of paper before the Inst. of Elec. Engrs. Discusses only circuits of electrically propelled dials, describing the various systems and presenting interesting oscillograph records. 2200 w. Elect'n, Lond—Feb. 18, 1910. Serial. 1st part. No. 12053 A.

Germany.

The State of the Electrical Industry in Germany in 1909. Dr. R. Bürner. Abstract of an article in the *Elektrotechnische Zeit.* Information relating to the various branches. 2000 w. Elect'n, Lond —March 18, 1910. No. 12718 A.

INDUSTRIAL ECONOMY.

China.

The Industrial Awakening of China (Die Industrialisierung Chinas). Waldemar Koch. A comprehensive review of industrial progress in the Chinese Empire along many lines. Ills. Serial. 1st part. 9000 w. Tech u Wirt—Feb., 1910. No. 12621 D.

Cost Systems.

See Drafting Rooms, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Education.

Impressions of a Visit to Berlin and Its Educational Establishments. Sir George Greenhill. Remarks on the Technische

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Hochschule of Charlottenburg and the Militärtechnische Akademie. 2000 w. Engr, Lond—Feb. 25, 1910. No. 12192 A.

Engineering Education in the Navy. From the annual report of H. I. Cone, engineer-in-chief, U. S. Navy. Information concerning the training given. 1200 w. Int Marine Engng—March, 1910. No. 12150 C.

Naval Schools in England (Scuole navali Inglesi). F. Grixoni. An examination and criticism of naval education in England. 7000 w. Riv. Marit—Feb., 1910. No. 12445 E. + F.

See also Laboratories, under ELECTRICAL ENGINEERING, MEASUREMENT.

Government Control.

An Analysis of the Natural Relations between the State and the Industrial Corporations. M. L. Byers. An interesting study of this economic problem. 8500 w. Pro St Louis Ry Club—Feb. 11, 1910. No. 12319.

Labor.

Cost of Living of the Working Classes in Belgium. Review of the fourth report of the Board of Trade. 3000 w. Ir & Coal Trade Rev—March 11, 1910. No. 12506 A.

Industrial Peace (La Paix dans l'Industrie). Sylvain Périssé. Suggests a profit-sharing scheme as the solution of the difficulties between capital and labor. 3500 w. All Indus—Feb., 1910. No. 12435 D.

Labor Insurance.

Employees' Benefit Systems. Gives methods in use by the Carnegie Steel Company, the Western Electric Company and the American Shipbuilding Company. 2500 w. Ir Age—March 31, 1910. No. 12783.

Management.

Organization by Production Factors. A. Hamilton Church. Seventh and concluding article of a series, discussing costs in relation to the financial books. 4500 w. Engineering Magazine—April, 1910. No. 12687 B.

Effect of Reorganization in the Canadian Rifle Factory. Frederick A. Waldron. Gives statements of payroll and output before and after reorganization. Ills. 1000 w. Am Mach—Vol. 33, No. 12. No. 12634.

Natural Resources.

The Waste of Natural Resources in the United States and Future Sources of Power (Die Vergeudung der natürlichen Hilfsquellen in den Vereinigten Staaten Nordamerikas und die Zukünftigen Quellen der Kraft). Walter Giesen. A German view. Ills. Serial. 1st part. 4500 w. Tech u Wirt—Feb., 1910. No. 12622 D.

Wage Systems.

Compensation of Workmen and Efficiency of Operation. H. L. Gantt. Discusses the determination and administration of the task and bonus, showing what has been accomplished. Third part of a serial. 3000 w. Engineering Magazine—April, 1910. No. 12682 B.

The Premium System for the Payment of Wages. H. F. Searle. Describes and discusses some of the best-known methods, showing the advantages or disadvantages of each. 3000 w. Jour of Acc—March, 1910 No. 12299 C.

Replacing Piece by Premium Plan of Paying for Work. L. Chamberlain. Explains the fundamental principle of premium work, and explains how the change can be accomplished. 3500 w. Am Mach—Vol. 33, No. 13. No. 12772.

Piecework. Explains this method of compensating workmen, and the training that should be given to enable the average workman to perform the task. 1500 w. Ry Age Gaz—March 4, 1910. No. 12127.

Relative Efficiency of the Day-Labor and Contract Systems of Doing Municipal Work. Harrison P. Eddy. Examines the advantages and disadvantages of the day-labor system, and the contract system, as applied to municipal work, giving statistics of interest and showing the cost to be less for contract work. General discussion. 14500 w. Jour Assn of Engng Socs—Jan., 1910. No. 12571 C.

MARINE AND NAVAL ENGINEERING.

Barges.

A Self-Dumping Barge. Illustrated description of a self-dumping barge for use at Stockholm. 1200 w. Engng—Feb. 18, 1910. No. 12061 A.

See also Motor Boats, under MARINE AND NAVAL ENGINEERING.

Battleships.

The Battleship of the Future. R. H. S. Bacon. Read before the Inst. of Nav. Archts. Reviews the chief features of battleship design and the trend, owing to progress in modern naval conditions. 4000 w. Engng—March 18, 1910. No. 12736 A.

U. S. S. South Carolina. H. C. Dinger. Description and report of official trials. Plate. 8000 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12700 H.

U. S. Battleship North Dakota. Charles B. Edwards. Illustrated description and report of trials. 9000 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12699 H.

We supply copies of these articles. See page 317.

The "Utah"—Our Latest Dreadnought. Illustration, with brief description of the vessel and its equipment. 1000 w. Sci Am—March 5, 1910. No. 12070.

H. M. Battleship "Vanguard." Brief illustrated description. 700 w. Engng—Feb. 18, 1910. No. 12062 A.

The Brazilian Battleship "Minas Geraes." Photographs and particulars of this latest Dreadnought. 1200 w. Sci Am—March 19, 1910. No. 12349.

The Brazilian Warship "Minas Geraes" (Le Cuirassé Brésilien "Minas Geraes"). E. Lignorelles. Brief description, with report of the official trials. Ills. 2500 w. Génie Civil—Feb. 19, 1910. No. 12441 D.

Destroyers.

Description and Trials of Torpedo-Boat Destroyers Flusser and Reid. William Nelson Little. Ills. 11000 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12695 H.

Education.

See same title, under INDUSTRIAL ECONOMY.

Evaporation.

Evaporating Plants on Board Ship. William J. Auken. Describes methods used for increasing the water supply. 2000 w. Int Marine Engng—March, 1910. No. 12151 C.

Fireboats.

The Seattle Fireboat Duwamish. H. Cole Estep. Drawings and description. 2500 w. Marine Rev—March, 1910. No. 12265.

Model Basins.

Experimental Tank at the National Physical Laboratory. Illustrated description of this concrete tank at Teddington and its construction. 1000 w. Engr, Lond—March 11, 1910. No. 12502 A.

The National Experimental Tank. R. T. Glazebrook. Read before the Inst. of Nav. Archts. Report on the progress of the national experimental tank at Teddington. Ills. 1500 w. Engng—March 18, 1910. No. 12733 A.

Motor Boats.

The Largest Commercial Gas Power Boats in the United States. Brief illustrated descriptions of the barges "Contra Costa" and "Benicia." 1800 w. Marine Rev—March, 1910. No. 12266.

See also Aeronautics, under MECHANICAL ENGINEERING, MISCELLANY.

Naval Architecture.

An Account of the Society for the Improvement of Naval Architecture. A. W. Johns. Read before the Inst. of Nav. Archts. An account of an institution founded nearly 120 years ago. 5500 w. Engng—March 18, 1910. No. 12737 A.

Navy Yards.

The Development of the Norfolk Navy Yard. A. C. Cunningham. Historical review, with plans. 5000 w. Pro U S Nav Inst—March, 1910. No. 12539 F.

Progress.

Improvements in Naval Engineering—Present Development and Future Possibilities. H. C. Dinger. How to increase the efficiency is discussed from the military viewpoint. 14500 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12696 H.

Propellants.

A Sketch of the History of Propellants. Sir Andrew Noble. Information relating to old gun-powders, comparing them with modern propellants. Short discussion. 4500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1910. No. 12548 N.

Propellers.

Geometry of the Turbine-Driven Propeller Dr. John Morrow. An investigation giving in tabular form the relations between developed and projected areas of a wide-bladed screw. 1200 w. Engng—March 11, 1910. No. 12399 A.

Rudders.

Experimental Determination of the Center of Pressure and the Resistance of Rudder Plates (Die Experimentelle Bestimmung des Druckmittelpunktes und Formwiderstandes von Ruderflächen). Dr. William Scholz. Describes the method. Ills. 1700 w. Schiffbau—Feb. 23, 1910. No. 12472 D.

Shipbuilding.

Sixty Years of Merchant Shipbuilding on the North-East Coast. Dr. G. B. Hunter and E. W. De Rusett. Reviews the history of the use of iron as the chief material in ship construction. 7000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1910. No. 12550 N.

See also Navy Yards, under MARINE AND NAVAL ENGINEERING.

Ship Design.

Wasted Horsepower and Economical Trim. William Russell White. A discussion of the needed experiments for the improvement of ship design and ship power. Ills. 5000 w. Pro U S Nav Inst—March, 1910. No. 12538 F.

Ship Stability.

The Stability of Ships. Discusses the conditions that produce a state of balance, and the problems of ship designing. Also the effect of loading. 2000 w. Engr, Lond—March 18, 1910. No. 12740 A.

Steam Auxiliaries.

Marine Auxiliaries. Sidney F. Walker. Considers condensers, evaporators, air-pump for condensers, circulating pumps, feed-water heaters, filters and grease extractors, etc. Ills. 4500 w. Int Marine Engng—March, 1910. No. 12153 C.

Steamboats.

The Stern-Wheel Steamer "Etobe" for Northern Nigeria. Illustrated detailed description of recently built vessels. 700 w. Engng—March 4, 1910. No. 12290 A.

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Steam Boilers.

Boiler Attachments and Funnel Draft. H. K. Spencer. Discusses the size of safety valves, stop valves, water columns, fuel pipes, funnels, etc. 3300 w. Inst Marine Engng—March, 1910. No. 12152 C.

See also Boiler Covering, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steamships.

The Performance of the Turbine Steamers "Mauretania" and "Lusitania." Abstract of an article in the engineering supplement of the *London Times*, by Sir William White. 1200 w. Eng News—March 24, 1910. No. 12589.

Notes on the Trials and Performance of the S. S. "Otaki," Fitted with a Combination of Reciprocating and Turbine Machinery. W. McK. Wisnom. This was the first merchant vessel fitted with this "combination system" of machinery. Report and discussion. 4 plates. 12500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1910. No. 12549 N.

The Second Turbine Steamer for the Japanese Volunteer Fleet. Illustrated description of the Umegaka Maru, a triple-screw turbine steamer. 2500 w. Inst Marine Engng—March, 1910. No. 12149 C.

A New Type of Ore Carrying Steamship. Illustrated description of the Vollrath Tham, built at the Hebburn Shipyard on the Tyne. 1200 w. Engr, Lond—March 18, 1910. No. 12743 A.

Details of the Russian Volunteer Steamer "Orel." Drawings, illustrations and description of five single-screw steamers and their machinery, intended for the Vladivostock and Shanghai service. Plate. 1200 w. Engng—March 11, 1910. No. 12397 A.

Twin-Screw Freight and Passenger Steamship "Cincinnati" (Doppelschrauben Fracht- und Passagierdampfer "Cincinnati," erbaut von der Schiffswerft F. Schichau, Elbing und Danzig). A. Oesten. Brief illustrated description, with detailed plans. 2200 w. Schiffbau—Feb. 9, 1910. No. 12471 D.

Steam Turbines.

Impulse Marine Turbines in Germany. Illustrates and describes designs and arrangement of machinery in German navy vessels, comparing with British practice. 2000 w. Engr, Lond—March 18, 1910. No. 12739 A.

A New Solution of the Problem of Marine Turbines (Nouvelle Solution du Problème des Turbines marines). M. Föttinger. Brief description of the Föttinger hydraulic transmission gear abstracted from the *Zeitschrift des Vereines Deutscher Ingenieure*. Ills. 1800 w. Rev de Mécan—Feb., 1910. No. 12416 E + F.

See also Steamships, under MARINE AND NAVAL ENGINEERING.

Torpedo Boats.

The Latest French Topedo Boat Destroyers. A critical review, with illustrations and report of trials. Plate. 2500 w. Engr, Lond—March 11, 1910. No. 12500 A.

A Boat-Torpedo of Enormous Destructive Power, Carrying Its Own Gasoline Engine and Crew. Illustrations and brief description of a semi-submarine boat-torpedo for the U. S. Navy, soon to be tested. 700 w. Eng News—March 17, 1910. No. 12309.

Tugs.

Twin-Screw Tug Boats for the North-Eastern Railway. Illustrated detailed description of two powerful tug boats recently built. 800 w. Engr, Lond—Feb. 25, 1910. No. 12194 A.

U. S. Merchant Marine.

The Merchant Marine and the Navy. T. G. Roberts. Discusses the ills of the U. S. merchant marine and the weakening effect on the navy. 15000 w. Pro U S Nav Inst—March, 1910. No. 12536 F.

Warships.

Fifty Years of Warship-Building on the Clyde. J. H. Biles. Describes the principal points in connection with the individual ships or classes of ships built on the Clyde during the last fifty years. Ills. 9000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1910. No. 12551 N.

MECHANICAL ENGINEERING.

Austin.

The New 15 Horsepower Austin. Calls attention to improvements in this new model. A larger stroke, four speeds, an interesting system of lubrication. 1200 w. Autocar—March 12, 1910. No. 12384 A.

Brakes.

Brakes and Their Limitations. Investigates the effect of brake action. 1700 w. Autocar—March 12, 1910. No. 12385 A.

Service and Emergency Brakes and Their Operation. Albert L. Clough. Considers the limit of brake power, the fault

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of hand brakes and exclusive pedal operation. 1000 w. Horseless Age—March 2, 1910. No. 12138.

Clutches.

Tendencies in Clutch Design. M. R. Wells. A comparison of types as shown at the recent exhibitions, discussing the cause of the changes. 1500 w. Horseless Age—March 9, 1910. No. 12232.

Clutch Repairs and Maintenance. Oliver Light. Analyzes some of the successful forms showing their weaknesses and suggesting methods of repairing them. Ills. 3500 w. Automobile—Feb. 24, 1910. No. 12043.

Control.

Pedals and Hand Levers. Illustrates and describes recent types. 1500 w. Horseless Age—Feb. 23, 1910. No. 12044.

Delaunay-Belleville.

The Delauany-Belleville Four-Cylinder "Ten." Illustrated description. 800 w. Auto Jour—Feb. 19, 1910. No. 12049 A.

Electrical Instruments.

Electrical Instruments for the Automobile. Joseph B. Baker. Illustrates and describes types of electrical indicating instruments for testing and maintaining the equipment of the car. 2000 w. Horseless Age—March 2, 1910. No. 12139.

Gaeth.

Gaeth Type XXI. Illustrated description of this company's improved 4-cylinder car. 1200 w. Horseless Age—March 23, 1910. No. 12679.

Gasoline Analysis.

Gasoline Analysis—Theoretical Computations of Gasoline Used in Tests. J. M. L. Howe and G. W. Lewis. 1500 w. Horseless Age—March 23, 1910. No. 12675.

Gears.

The Correct Gear-Ratio for a Touring Car. Describes an ingenious graphic method of determination. 1800 w. Autocar—March 19, 1910. No. 12714 A.

A New Type of Differential Gear. Illustrated description of the Graham differential gear in which the power is taken by the wheel offering the greater resistance. 1200 w. Autocar—March 19, 1910. No. 12713 A.

Houpt-Rockwell.

Original Features in Houpt-Rockwell "60." Illustrated description. 1500 w. Horseless Age—March 23, 1910. No. 12678.

Ignition.

Magneto versus Battery Ignition. Albert L. Clough. Presents the advantages and disadvantages of the two systems. 700 w. Horseless Age—March 2, 1910. No. 12136.

Multiple Coils versus the High Tension Distributor. Albert L. Clough. Reviews the advantages and disadvantages of each. 600 w. Horseless Age—March 2, 1910. No. 12137.

Ignition Advance. H. H. Brown. Explains briefly the causes rendering ignition advance necessary, and discusses the effect of compression on rapidity of combustion, and related matters. 2500 w. Horseless Age—Feb. 23, 1910. No. 12045.

Some Characteristic Features of High and High-Low Tension Magnetos. Albert L. Clough. Discusses these two types. 1800 w. Horseless Age—March 9, 1910. No. 12231.

Probable Future Developments in Ignition Practice. Albert L. Clough. Suggestions, describing a dynamo lighting ignition outfit, and discussing probable changes. 2000 w. Horseless Age—March 16, 1910. No. 12343.

Lorraine-Dietrich.

The Lorraine-Dietrich "Twelve-Sixteen." Illustrated description of this small car of the 75 M.M. class. 900 w. Auto Jour—March 5, 1910. No. 12275 A.

Lubrication.

How Efficient Lubrication Reduces Maintenance. A study of the proper and complete lubrication of automobiles. 2000 w. Automobile—March 17, 1910. Serial. 1st part. No. 12362.

Motors.

The One-Stroke Engine. Illustrated description, showing the functions of the various component members. 1500 w. Autocar—Feb. 19, 1910. No. 12048 A.

Long Stroke versus Short Stroke Motors. Elwood Haynes. Discusses the ratio between bore and stroke. 3000 w. Horseless Age—March 23, 1910. No. 12676.

Some Two-Cycle Phenomena. Dr. Charles W. Snyder. Gives results of experimental work with a two-cycle engine, calling attention to facts of interest to two-cycle designers. Ills. 4000 w. Horseless Age—March 2, 1910. No. 12135.

The Enderby-Johnson Experimental Engine. Brief illustrated description of a double-acting two-stroke model. 1000 w. Auto Jour—Feb. 26, 1910. No. 12175 A.

Shock Absorbers.

Automobile Shock Absorbers (Les Amortisseurs d'Automobiles). E. Girardault. A review of their uses, the different types and examples of each type. Ills. Serial. 1st part. 3500 w. Génie Civil—Feb. 5, 1910. No. 12437 D.

Speedometers.

The Speedometer Question in Switzerland (Die Geschwindigkeitsmesserfrage in der Schweiz). Herr Pflug. An outline of the recent regulations issued by the Swiss Department of the Interior respecting speed indicating devices for automobiles. 3500 w. Zeitschr d Mit Motorwagen Ver—Feb. 15, 1910. No. 12485 D.

Results of Tests of Speedometers (Ergebnis der Prüfung von Geschwindigkeitsmessern). Herr Pflug. Gives results of tests on twenty-two devices in-

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vestigated in connection with the recent Swiss regulations. 6500 w. Zeitschr d Mit Motorwagen Ver—Feb. 28, 1910. No. 12486 D.

Steering Gears.

Some Notes on Steering Connections. J. L. Napier. Explains the principles involved in the designing of steering gears. 1400 w. Autocar—Feb. 19, 1910. No. 12047 A.

Talbot.

The 15 h. p. Four-Cylinder Talbot. Illustrated description of detail improvements introduced. 1200 w. Autocar—March 19, 1910. No. 12712 A.

Taximeters.

Taximeters and Public Cab Operation. Harold Brown. Discussion of instruments for the registration of fares and charges, illustrating and describing types in common use. 4000 w. Com Veh—March, 1910. No. 12161 C.

Tires.

Some Common Tire Fallacies Exploded. D. W. Samways. Abstract of paper read before the Roy. Auto Club of Gt. Britain and Ireland. An explanation of the forces acting on the rim and wheel, discussing the advantages of a high tire and a low one, and how to prolong their life. 1700 w. Automobile—March 3, 1910. No. 12093.

Transmission Loads.

Graphical Determination of Transmission Loads. L. C. Freeman. Analysis, with the idea of determining the maximum loads imposed on ball bearings by the action of the gears. 2000 w. Automobile—March 17, 1910. No. 12361.

Transmissions.

Some Transmission Mechanisms in Modern Shaft-Driven Automobiles. Forrest R. Jones. Discusses the location of the transmission, the use of one universal joint as compared with the earlier practice of using a pair, and other features. 2200 w. Automobile—March 3, 1910. No. 12094.

COMBUSTION MOTORS.

Aeronautic Motors.

Motors for Aerial Navigation. J. S. Critchley. Read before the Inc. Inst. of Auto. Engrs. States the requirements, illustrating and describing types of each class. 3500 w. Mech Engr—Feb. 18, 1910. Serial. 1st part. No. 12057 A.

Carburetters.

Carburetters for Internal-Combustion Engines. A carburetter designed and patented by Sir Hiram Maxim is illustrated and described. 2200 w. Prac Engr—March 18, 1910. No. 12723 A.

Gas Engines.

The Gas Engine. Dr. Charles E. Lucke. Abstract of the fifth Hewitt lecture, delivered at Cooper Union. 1500 w. Power—March 15, 1910. No. 12269.

Constructive Details of Double-Acting Four-Stroke Cycle Gas Engines (Konstruktive Einzelheiten an doppeltwirkenden Viertaktgasmaschinen). R. Drawe. A discussion of cylinder, piston and valve construction. Ills. Serial. 1st part. 4000 w. Stahl u Eisen—Feb. 9, 1910. No. 12458 D.

See also Blowing Engines, under MINING AND METALLURGY, IRON AND STEEL.

Gasoline Engines.

A Novel Hydrocarbon Engine. Diagrams and description of a 50-h.p., 4-cylinder motor with variable piston stroke. The invention of Messrs. Gill and Aveling. 900 w. Sci Am Sup—March 26, 1910. No. 12646.

See also Aeronautics, under MISCELLANY.

Gas Producers.

Fuels for Gas Engines. Dr. Charles E. Lucke. Part of the sixth Hewitt lecture delivered at Cooper Union. Discusses the gasification of coal for gas-engine purposes. Ills. 1500 w. Power—March 22, 1910. Serial. 1st part. No. 12512.

Gas Turbines.

The Gas Turbine. A. W. H. Griepe. Considers the Stolze proposed turbine, the Wegner turbine, and the author's design. Ills. 1000 w. Power—March 8, 1910. No. 12172.

Ignition.

Electrical Ignition in Combustion Motors (Allumage électrique des Moteurs à Explosion). A. Bainville. A review of the systems of producing the current and of sparking devices. Ills. 3000 w. L'Elecn—Feb. 12, 1910. No. 12428 D.

Oil Engines.

Weights of Moving Parts in Oil Engines. Frederick Strickland. Considers that pistons, connecting rods, etc., are often made too heavy. 1500 w. Horseless Age—March 23, 1910. No. 12677.

The Extension of the Use of the Diesel Motor (Der Dieselmotor und seine Verbreitung). Brief notes on installations of Sulzer and Augsburg-Nürnberg Diesel motors for driving electric generators. Ills. 2200 w. Elek Kraft u Bahnen—Feb. 24, 1910. No. 12603 D.

See also Centrifugal Pumps, under HYDRAULIC MACHINERY.

Producer Gas.

An Ambitious Scheme of Heat Utilization. Illustrates and outlines a plant developed by Dr. J. M. W. Kitchen of East Orange, N. J., aiming to utilize all heat carried by heated air or heated water. 3500 w. Met Work—March 5, 1910. No. 12131.

Economizing the Waste Heat in Power Generation. J. M. W. Kitchen. States the more important principles to be applied in saving heat in power generation,

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giving diagram and explanation of the author's composite system. 1500 w. Power —March 29, 1910. No. 12747.

HEATING AND COOLING.

Air Purification.

See Ozone, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Central Plants.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Hot-Air Heating.

Opportunities in the Field of Warm Air. James D. Hoffman. Discusses defects in furnaces and furnace heating installations, suggesting remedies. 2000 w. Met Work —March 19, 1910. No. 12360.

Furnace Heating of an Eight-Room School. Illustrates and describes an arrangement including an exhaust fan driven by a water motor. 2200 w. Met Work—March 12, 1910. No. 12252.

Liquid Air.

Industrial Applications of Extremely Low Temperatures (Quelques Applications industrielles des très basses Températures). A. Lancien. A review of the uses of liquid air and other liquified gases. 2400 w. Rev d'Econ Indus—Feb. 20, 1910. No. 12409 D.

Refrigeration.

Refrigeration for Cold Storage. Nelson Waite. Discusses the comparative value of direct and indirect refrigeration for cold storage plants. 2000 w. Ice & Refrig —March, 1910. No. 12165 C.

A Two-Hundred Ton Ice-Making Plant. Illustrated description of a large plant at Grimsby, Eng., on the ammonia-compression system. Plate. 800 w. Engr, Lond —Feb. 18, 1910. No. 12065 A.

The Brewing Exposition in Munich, 1909 (Von der Brauereiausstellung in München 1909). C. Guillery. Describes the exhibits in the refrigeration section. Ills. Serial. 1st part. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 5, 1910. No. 12608 D.

See also Calorimetry, under MEASUREMENT; and Refrigeration, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

School Buildings.

Heating and Ventilating Minnesota Schools. Illustrates and describes practice in accord with the regulations of the Minnesota State Board of Health. 1200 w. Met Work—Feb. 26, 1910. No. 12042.

Steam Heating.

Steam Heating Systems in Common Use. J. P. Lisk. Discusses their adaptability and gives tables showing the size of pipe to supply a given amount of radiation. 2000 w. Power—March 15, 1910. No. 12268.

Successful Heating of Our Homes. A. G. King. This number discusses the principal points which make a heating boiler effective. 1800 w. Archts & Bldrs' Mag —Feb., 1910. Serial. 1st part. No. 12211 C.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Design, Construction and Operation of High-Lift Centrifugal Pumps. Franz zur Nedden. This fourth part of a series considers the turbo-pump diagram and its practical interpretation in service. 3500 w. Engineering Magazine—April, 1910. No. 12685 B.

The High-Pressure Fire-Service Pumps of Manhattan Borough, City of New York. Discussion at St. Louis of the paper by Prof. R. C. Carpenter. 4000 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12353 F.

Centrifugal Pumps Operated by Diesel Motors (Wasserwerke mit Kreiselpumpen und Dieselmotorenbetrieb). Discusses the technical and economic success of plants of this type, illustrating a number of installations. 2300 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 28, 1910. No. 12402 D.

Presses.

See Cylinders, under MACHINE ELEMENTS AND DESIGN.

Pumping Plants.

Steam-Driven Pumping Plant for Deep Wells and Bore-Holes. Alfred Towler. Read before the Assn. of Water Engrs. Indicates the principles which affect the durability and efficiency of rod-pumps, and describes the plant at Stocks Well Pumping Station. Ills. 6400 w. Engng—Feb. 25, 1910. No. 12190 A.

Tests and Notes on Method of Operation of a Producer Gas Pumping Plant. James R. Fitzpatrick. Illustrated account of the plant of the Grand Rapids Hydraulic Company. Discussion. 5500 w. Pro Am W-Wks Assn—1909—No. 12761 N.

See also Dams, and Water Works, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

Roberts Direct-Acting Hydraulic Pump. Illustrates and describes a combination of a piston-pump, a piston and plunger pump, and a ram-pump. 1000 w. Engng—March 11, 1910. No. 12395 A.

Suction Height of Piston Pumps (Saughöhe und Ansaugen der Kolbenpumpen). F. Schönberger. A discussion of results obtained in practice. Ills. 3800 w. Zeitschr d Ver Deutscher Ing—Feb. 26, 1910. No. 12618 D.

Turbine Governors.

A New High-Pressure Turbine Governor (Eine neue Hochdruckturbinenregulierung). Andreas Stamm. Illustrated description of a regulating device applied to a 5,500 horse-power Pelton wheel. Serial. 1st part. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 28, 1910. No. 12401 D.

We supply copies of these articles. See page 317.

Turbines.

Design and Construction of Four 9000 H. P. Turbines. H. Birchard Taylor. Illustrated description of hydraulic turbines installed in the Little Falls plant on the Spokane River, Washington. 2200 w. Am Mach—Vol. 33. No. 12. No. 12638.

Standard Coefficients of Modern High-Pressure Francis Turbines (Massgebende Koeffizienten von modernen Hochdruck-Francisturbinen). Mario Dornig. Mathematical discussion of the coefficients and the relations between them. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 28, 1910. No. 12403 D.

Turbine Tests.

Acceptance Tests of the Turbines and Regulators for the Gullspang Power Plant, Sweden (Abnahmeversuche an den Turbinen und Regulatoren des Wasserkraftwerkes Gullspang, Schweden). H. Th. Holm. Describes and gives results of tests on the 4,000 horse-power double Francis turbines. Ills. Serial. 1st part. 800 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 28, 1910. No. 12400 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Why Have Ball Bearings Been a Failure? E. J. Baechle. Discusses the results of Prof. Stribeck's investigations and researchs in the rolling and sliding action of balls. Ills. 1500 w. Am Mach—Vol. 33. No. 12. No. 12636.

Cylinders.

Design of Hydraulic Press Cylinders. A. Lewis Jenkins. Suggestions, with formulae for thick cylinders. 1500 w. Am Mach—Vol. 33. No. 13. No. 12771.

Drafting Rooms.

An English Drafting Room and Efficient Cost System. I. William Chubb. Especially describes the division of work and fixing responsibility. 3000 w. Am Mach—Vol. 33. No. 9. No. 12120.

Gears.

Solution of Epicyclic Gearing by the Method of Levers. John S. Myers. Gives problems illustrating the method known as separate motions, and applying the lever method. Ills. 2000 w. Mach, N Y—March, 1910. No. 12072 C.

The Calculation of Spur-Gear Teeth (Sur le Calcul des Dents d'Engrenages droits). R. André. Mathematical demonstration of method. Ills. 3000 w. All Indus—Feb., 1910. No. 12434 D.

Gyroscopes.

How a Gyroscope Acts. C. E. Wolff. Explains the nature of the action and how to calculate the turning moment corresponding to any rotation of the axis. 1000 w. Mech Engr—Feb. 25, 1910. No. 12184 A.

Mechanics of the Gyroscope. Irving P. Church. A study of its properties. Mathematical. 3500 w. Cornell Civ Engr—March, 1910. No. 12544 C.

Shrinkage Stresses.

Shrinkage and Forced Fits and the Stresses They Produce. A. Lewis Jenkins. An investigation of such stresses, with allowances such as are commonly used in practice, illustrating by examples. 2500 w. Eng News—March 17, 1910. No. 12308.

Springs.

Slide Rule for Helical Spring Calculations. M. E. Davis. Gives a reproduction of the graduations on a slide rule used for such calculations, with directions for its use. 800 w. Mach, N Y—March, 1910. No. 12073 C.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

See Electric Driving, under POWER AND TRANSMISSION.

Brass Founding.

Casting Long Liners. Walter J. May. Suggestions helpful in casting long, thin articles in copper alloys. 600 w. Prac Engr—March 11, 1910. No. 12387 A.

Bronze Founding.

The Gating and Pouring of Manganese-Bronze. W. R. Dean. An illustrated article giving suggestions for successful work. 1500 w. Brass Wld—March, 1910. No. 12540.

Castings.

Segregation Phenomena in Steel Castings. S. S. Knight. Read at meeting of the Phila. Found. Assn. An illustrated account of results of recent metallographic investigations. 3000 w. Ir Age—March 3, 1910. No. 12058.

Cupola Practice.

Theoretical Notes on Cupola Reactions (Theoretische Betrachtungen über die Vorgänge im Kupolofen). H. Holm. Discusses the heat balance of the cupola. Ills. 2700 w. Stahl u Eisen—Feb. 2, 1910. No. 12454 D.

Drilling Machines.

Radial Drilling Machines Break Drills and Records. F. E. Bocorselski. Illustrated account of drilling tests made by the American Locomotive Co. 1500 w. Am Mach—Vol. 33. No. 11. No. 12334.

Foundry Practice.

Steel Foundry Practice. Percy Longmuir. Read before the Manchester Assn. of Engrs. A survey of steel foundry practice, the processes followed, and the difficulties met. 3000 w. Mech Engr—March 4, 1910. No. 12285 A.

Foundry Ventilation.

The Removal of Dust in Iron Works and Foundries (Die Staubbeseitigung in Hüttenwerken und Giessereien). Ernst A. Schott. Illustrated detailed description of dust-removal systems and devices applicable to individual machines. Serial. 1st part. 4000 w. Stahl u Eisen—Feb. 2, 1910. No. 12453 D.

We supply copies of these articles. See page 317.

Gear Cutting.

Self Generating Spur Gear Machine of English Design. I. W. Chubb. Illustrated description of the Sunderland gear generator. 2000 w. Am Mach—Vol. 33. No. 10. No. 12236.

A Simple Jig for Cutting Worm-Wheel Teeth. Illustrates and describes a device for cutting standard worm wheels. 2500 w. Prac Engr—March 18, 1910. No. 12722 A.

Lathes.

12-Inch High-Speed Lathe. Illustrates and describes a new high-speed lathe with all-gear single-pulley head. 500 w. Engr, Lond—March 4, 1910. No. 12295 A.

Recent High-Speed Lathes (Neue Schnelldrehbänke). Fr. W. Hülle. Detailed descriptions of two new German lathes. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 26, 1910. No. 12615 D.

Machine Tools.

Special Machines for Making Large Spherical Bearings. Robert Reid. Illustrates and describes types. 1000 w. Am Mach—Vol. 33. No. 12. No. 12637.

Metal Spinning.

Metal Spinning. William A. Painter. Illustrates and describes in detail the various operations of spinning metal. 4000 w. Mach, N Y—March, 1910. No. 12071 C.

Molding.

Match-Plates for Stove Castings. Illustrates and describes the method of molding stove plate by the use of hinged match-plates and flasks. 6000 w. Foundry—March, 1910. No. 12091.

Molding Machines.

Machine Molding of Cast Tubes (Maschinelle Herstellung von Formen für stehend zu giessende Rohre). R. Ardelt. Describes a number of machines and processes. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—Feb. 2, 1910. No. 12452 D.

Pipe Founding.

See Molding Machines, under MACHINE WORKS AND FOUNDRIES.

Planing Machines.

Direct Electric Drive for Planing Machines (Direkter elektrischer Antrieb von Hobelmaschinen). Describes the system of the Felten & Guilleaume-Lahmeyerwerke. Ills. 2200 w. Zeitschr f Werkzeug—Feb. 5, 1910. No. 12492 D.

Presses.

Testing Power Presses to Find Capacity and Rating. H. Gansslen. Gives suggestions for researches in selecting a press for doing certain work. Ills. 2800 w. Am Mach—Vol. 33. No. 10. No. 12237.

Shop Appliances.

Making a Precision Dividing Wheel. Illustrated description of a wheel made by grinding a series of disks and clamping them around a rim of such diameter that the disks all touch each other and the rim simultaneously. 1500 w. Mach, N Y—March, 1910. No. 12076 C.

Turret Lathe Equipment for Making Automobile Parts. C. L. Goodrich. Illustrates and describes a number of recent adaptations for producing rapid work. 1000 w. Am Mach—Vol. 33. No. 10. No. 12235.

Milling Fixtures for Automobile Parts. E. H. Pratt. Illustrates and describes special fixtures for producing accurate work. 1000 w. Mach, N Y—March, 1910. No. 12080 C.

Shop Floors.

See Concrete, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Shop Practice.

Some Notes on Shop Economics. C. E. Coolidge. Brief illustrated discussion of machine shop equipment. 2000 w. Sib Jour of Engng—March, 1910. No. 12554 C.

Machine Shop Practice. The present number deals with tool grinding. Plate. 1200 w. Mach, N Y—March, 1910. No. 12079 C.

Modern Automobile Building Methods in a French Shop. Illustrates and describes machines used in making the Berliet car in Lyons, France. 1200 w. Am Mach—Vol. 33. No. 9. No. 12118.

Methods of Handling Automatic Turret Work. F. A. Stanley. Illustrates and describes ways and means of handling various pieces upon chuck or face plates. 2500 w. Am Mach—Vol. 33. No. 9. No. 12119.

Methods of Holding and Machining Lathe Work. F. A. Stanley. Illustrates and describes interesting adaptations of the turret machine with automatic chuck. 1200 w. Am Mach—Vol. 33. No. 13. No. 12770.

The Machining of Large Work by Unusual Methods. Illustrates and describes special tools and devices used on large gas engines. 2000 w. Am Mach—Vol. 33. No. 9. No. 12121.

Lathe Building Operations in Well Equipped Shop. F. A. Stanley. Half tones, engravings and descriptions of tools employed in machining and testing parts in a Cincinnati shop. 2200 w. Am Mach—Vol. 33. No. 11. No. 12335.

Shop Kinks. Gives the nineteenth to twenty-fifth collections inclusive, with also a collection of miscellaneous kinks. Ills. 5000 w. Ry Age Gaz—March 4, 1910. No. 12130.

See also Shops, under RAILWAY ENGINERING, MOTIVE POWER AND EQUIPMENT.

Shops.

Shrinking and Tempering Shop for Guns at Woolwich Arsenal. A short account of previous methods and appliances for dealing with this problem, and illustrated detailed description of this new shop. Plate. 4000 w. Engng—Feb. 25, 1910. No. 12188 A.

The Works of Messrs. Ackroyd and

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Best, Limited, Morley, Leeds. Illustrated description of these works and of the manufacture of Hailwood's safety lamp and underground relighter. 3500 w. Col Guard March 18, 1910. No. 12729 A.

Shop Ventilation.

The Removal of Fumes in Factories (Elimination des Buées industrielles). Paul Razous. Discusses the formation of fumes in various industries, their hygienic effects, and methods of removing them. Serial. 1st part. 3500 w. Rev d'Econ Indus—Feb. 20, 1910. No. 12407 D.

Tempering.

See Shops, under MACHINE WORKS AND FOUNDRIES.

Tin-Box Making.

A Tin Box Factory at Barking. Illustrates and describes methods used at this factory, with plan of the works. 1200 w. Engr, Lond—March 4, 1910. No. 12294 A.

Tool Making.

A Central Tool Dressing Plant in a Navy Yard. W. H. Taylor. Illustrated description of a plant supplying tools for several yards on the Atlantic coast. 2500 w. Am Mach—Vol. 33. No. 10. Serial. 1st part. No. 12233.

Tools.

Circular Form and Cut-Off Tools. Douglas T. Hamilton. Illustrates and describes the practice for the Brown & Sharpe screw machines. 3000 w. Mach, N Y—March, 1910. No. 12075 C.

Welding.

Electric and Autogenous Welding. Editorial review of what has been accomplished, showing the value of these methods. 3000 w. Engng—March 4, 1910. No. 12291 A.

Autogenous Welding. Fred W. Wolf, Jr. Discusses the processes and the applications to cooling apparatus. 3300 w. Ice & Refrig—March, 1910. No. 12166 C.

Oxy-Acetylene Welding. H. S. Smith. Describes the plants employed in the high and low pressure systems and their fields of operation, and the classes of work on which the system can be advantageously employed. General discussion. 8000 w. Jour Soc of Arts—Feb. 25, 1910. No. 12174 A.

Electric Welding of Copper, Brass and Aluminum. A. E. Buchenberg. Explains some of the difficulties and describes the electric method, giving cost. 1800 w. Mach, N Y—March, 1910. No. 12077 C.

A Striking Oxy-Carbi Boiler Fusion Weld. Frank C. Perkins. Illustrates and describes the welding of a patch in the flue sheet of the fire-box. 1000 w. Boiler Maker—March, 1910. No. 12227.

Electrolytic Production of Hydrogen and Oxygen for Autogenous Welding (Die Selbstherstellung von Wasserstoff und Sauerstoff durch Elektrolyseure für autogene Schweissung). Herr Hopfer discusses the commercial production of these gases, the equipment, cost, etc. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1910. No. 12612 D.

An Experimental Study of the Strength of Welds (Etude experimentale de la Resistance des Soudures). Ch. Fremont. Reports results of tests on welds made by various processes. Ills. 6500 w. Génie Civil—Feb. 26, 1910. No. 12443 D.

Wood-Working Machinery.

Safety Appliances for Planers (Appareils de Protection pour les Dégauchisseuses). Henri Mamy. Describes a number of protective devices. Ills. 2000 w. Génie Civil—Feb. 19, 1910. No. 12442 D.

MATERIALS OF CONSTRUCTION.

Alloys.

A Study of Metallic Alloys (Etude sur les Alliages Métalliques). J. Chaussin. A general review of the structure of alloys, effects of working and heat treatment, etc. 4200 w. Rev d'Econ Indus—Feb. 20, 1910. No. 12408 D.

Alloy Steels.

Trend of Steel Specifications to Meet Present Requirements. C. A. Tupper. A review of the various steel alloys and their capacities. 7000 w. Am Mach—Vol. 33, No. 12. No. 12635.

The Various Effects of Manganese in Steel. E. F. Lake. A review of the properties and effects of this element. 1500 w. Am Mach—Vol. 33, No. 10. No. 12238.

Aluminium.

The Analysis of Aluminium and Its Alloys. Richard Seligman and F. J. Willott. Describes rapid analytical methods used in the industrial laboratory. 4000 w. Mech Engr—March 11, 1910. No. 12389 A.

Bronzes.

The Elastic Limit of Manganese and Other Bronzes. J. A. Capp. A report of tests showing that the value commonly obtained from rapid commercial tests on bronze may be quite misleading. 2500 w. Jour Am Soc of Mech Engrs—March., 1910. No. 12352 F.

Cast Iron.

A Comparison of Specifications for Cast Iron in Germany and the United States (Vergleichende Zusammenstellung der Lieferbedingungen für Gusseisen in Deutschland und den Vereinigten Staaten). Presents the specifications in parallel tables. Ills. 2000 w. Stahl u Eisen—Feb. 2, 1910. No. 12455 D.

See also Test Bars, under MEASUREMENT.

Metallography.

The Properties of Metals and Metallic Compounds (Die Eigenheiten von Metallen und Metallverbindungen). G. Goldberg. A brief review of metallographic principles. Serial. 1st part. 1500 w. Giesserei-Zeit—Feb. 15, 1910. No. 12464 D.

The Theoretical Form of the Cooling Curves of Binary Alloys (Sur la Forme Théorique des Courbes de Refroidissement des Mélanges binaires). E. Rengade. A general discussion of the characteristics exhibited by cooling curves. Ills. 3600 w. Rev de Métal—Feb., 1910. No. 12413 E + F.

The Importance of Metallography in the Iron Industry (Die Bedeutung der Metallographie für die Eisenindustrie). P. Oberhoffer. A discussion of its field of usefulness and a review of the metallography of iron and steel. Ills. 4000 w. Stahl u Eisen—Feb. 9, 1910. No. 12457 D.

The Influence of Manganese Sulphide on Iron and Steel. Donald M. Levy. Read before the Staffordshire Iron & Steel Inst. Gives results of scientific investigations. Ills. 6000 w. Ir Trad Rev—March 3, 1910. No. 12112.

Refractory Materials.

See Boiler Furnaces, under STEAM ENGINEERING.

Steel.

The Hardness of Quenched Steels, with Particular Reference to Quenched Case Hardened Steels. Messrs. Portevin and Berjot, in *Revue de Metallurgie*. Gives an account of researches and conclusions. 800 w. Ir Age—March 31, 1910. No. 12782.

Observations on Segregation Phenomena as Applied to Cast Steels. S. S. Knight. Read before the Phila. Found. Assn. Discusses the value of microscopy and synthetic chemistry in metallographic investigation. Ills. 2000 w. Ir Trd Rev—March 10, 1910. No. 12224.

MEASUREMENT.

Calorimetry.

Specific Heat of Some Calcium Chloride Solutions Between — 35° C. and + 20° C. H. C. Dickinson, E. F. Muller, and E. B. George. An investigation of the values of specific heat at temperatures employed in refrigeration practice, comparing two methods. Ills. 6500 w. Bul Bureau of Stand—Feb., 1910. No. 12563 N.

Experimental Determination and Registration of the Calorific Power of Gases (Détermination expérimentale et Enregistrement du Pouvoir calorifique des Gaz). E. Lemaire. Description of the construction and use of the Junkers calorimeter. Ills. 2500 w. Génie Civil- Feb. 12, 1910. No. 12440 D.

Dynamometers.

An Improved Absorption Dynamometer. C. M. Garland. Illustrates and describes a magnetic absorption dynamometer and its operation. 1200 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12359 F.

Some Recent Dynamometers (Quelques Dynamomètres récents). An illustrated review of dynamometers invented during the last eight years. Serial. 1st part. 4000 w. Rev de Mécan—Feb., 1910. No. 12423 E + F.

Gauges.

Proposed Decimal Limit Gauge for Wire, Sheet Metal, and Tubing. George E. Goddard. Explains the need of concerted attention to the subject of these gauges, and gives a table of the proposed gauge. 2500 w. Horseless Age—March 23, 1910. No. 12674.

Thread Gages for Bolt-Work on French Railways. Charles B. King. Illustrates and describes the system employed by the State Railways of France. 700 w. Mach, Ry Ed—Feb., 1910. No. 12273 C.

Impact Tests.

Comparative Static and Dynamic Bending Tests on Notched Bars (Essais comparatifs de Flexion statique et dynamique sur Barreaux entaillés). A. Léon and P. Ludwik. Translated from *Oesterreichische Wochenschrift für den öffentlichen Baudienst* for Feb. 13, 1909. Ills. 2300 w. Rev de Métal—Feb., 1910. No. 12415 E + F.

Pressure.

Testing Pressures with Lead Cylinders. W. T. Sears. Gives curves and records of compression tests, and remarks. 1500 w. Am Mach—Vol. 33. No. 10. No. 12234.

Steam Meters.

The Pitot Tube as a Steam Meter. Discussion of paper by George F. Gebhardt. 1200 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12358 F.

Tests with Recording Steam Meters (Versuche mit selbstaufzeichnenden Dampfmessern). K. Rummel. A discussion of the theory of their design, and detailed results of an extended investigation. Ills. Serial. 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1910. No. 12610 D.

Test Bars.

A Report on Cast Iron Test Bars. Discussion of A. F. Nagle's paper. 1200 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12356 F.

POWER AND TRANSMISSION.

Air Compressors.

Air Compressors. A study of the application of various formulæ to practical work. 800 w. Prac Engr—March 4, 1910. No. 12283 A.

Air Compressor Testing. E. A. Fessenden. Discusses the displacement method and the orifice method for determining the capacity. Also a modified orifice method and the Venturi meter method. Ills. 3000 w. Mach, N Y—March, 1910. No. 12074 C.

Compressed Air.

Compressed Air and Its Uses. Discusses the industrial value of compressed air, illustrating and describing types of compressors, and applications. 5000 w. Ir Age—March 3, 1910. Serial. 1st part. No. 12052.

We supply copies of these articles. See page 317.

Pneumatic Hose Fittings. Illustrates and describes the "Titan" fittings, designed to lessen accidental losses and prevent improper use. 1200 w. Engr, Lond—Feb. 18, 1910. No. 12066 A.

Electric Driving.

The Operation and Care of Small Electrical Machinery. Henry B. Bixler. Practical suggestions for making repairs, locating troubles, and removing the causes. Plate. 2500 w. Mach, N Y—March, 1910. No. 12078 C.

Location and Care of Motors in Industrial Plants. William Kavanagh. Suggestions for the arrangement and mounting of motors. 1200 w. Elec Wld—March 3, 1910. No. 12106.

The Powering of Boiler Shops. D. S. Downs. Discusses the three classes of electrical systems which fulfill the power requirements of the boiler shop. Ills. 1600 w. Boiler Maker—March, 1910. No. 12229.

Two-Motor Drive for Web Printing Press. S. H. Sharpsteen. Discusses how standard motors and control devices may be applied to the electrical operation of printing presses. 1500 w. Elec Wld—March 3, 1910. No. 12105.

Electricity in a Modern Laundry. Illustrated description of an installation in San Francisco. 1500 w. Elec Rev, N Y—March 19, 1910. No. 12363.

Ring Spinning Frames (Le Métier continu à Filer). An exhaustive discussion of the application of electric power to ring spinning frames prepared by Brown, Boveri & Co. Ills. 5000 w. All Indus—Feb., 1910. No. 12433 D.

See also Planing Machines, under MACHINE WORKS AND FOUNDRIES.

Lubricants.

See Fuel Purchasing, under STEAM ENGINEERING.

Mechanical Plants.

Heating and Ventilating the Morgan Memorial Building, Hartford, Conn. Putnam A. Bates. Brief illustrated description of this beautiful art-building, with detailed description of the mechanical arrangements for heating and ventilation. 4000 w. Eng Rec—March 26, 1910. No. 12666.

Power Generation.

Steam Boilers and Combustion. Charles Edward Lucke. Third Hewitt lecture at Cooper Union hall. Explains the principles upon which boilers are constructed and outlines the essentials of combustion. 2500 w. Power—March 1, 1910. No. 12041.

Economy in Generating Steam Power. Charles Edward Lucke. Fourth Hewitt lecture in Cooper Union hall. Considers the saving effected by the use of apparatus to reclaim waste heat, and the influence of compounding engines on economy. 2000 w. Power—March 8, 1910. No. 12173.

Power Plants.

Johnson and Johnson's New Power Plant. Warren O. Rogers. Illustrated description of a plant in New Brunswick, N. J., furnishing power to manufacture surgical dressings and hospital supplies. 2500 w. Power—March 29, 1910. No. 12745.

Composite Power Generation. J. M. W. Kitchen. Gives reasons for the restricted use of gas power, and reasons favoring the composite use of steam and gas. 1500 w. Power—March 22, 1910. Serial. 1st part. No. 12511.

See also Producer Gas, under COMBUSTION MOTORS.

Shafting.

Line-Shaft Efficiency, Mechanical and Economic. Henry Hess' paper on this subject is discussed. 5000 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12354 F.

Turbo-Compressors.

Tests of a Jaeger Turbo-Compressor (Versuche an einem Turbinengebläse der Bauart C. H. Jaeger). H. Mitter. Describes in detail the machine and the tests and gives results. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 5, 1910. No. 12609 D.

STEAM ENGINEERING.

Boiler Corrosion.

The Deterioration of Steam Boilers. Francis H. Davies. Discusses external and internal corrosion and their preventives. 1500 w. Prac Engr—Feb. 25, 1910. No. 12182 A.

Electro-Chemical Action and Boiler Corrosion. Editorial review of experiments carried out by Prof. C. F. Burgess, of the Univ. of Wis. 3000 w. Engng—Feb. 25, 1910. No. 12189 A.

Boiler Covering.

Notes on Boiler Covering. A. P. Strohmenger. Lectures delivered at the meeting of the Inst. of Marine Engrs. Discusses heat losses and the efficiency of coverings. 1500 w. Prac Engr—March 18, 1910. Serial. 1st part. No. 12724 A.

Notes on Boiler Covering. A. P. Strohmenger. Lecture before the Inst. of Marine Engrs. Discusses the properties of a desirable covering. 2500 w. Mech Engr—March 11, 1910. No. 12390 A.

Boiler Design.

The Best Form of Longitudinal Joint for Boilers. Discussion of F. W. Dean's paper. 1700 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12355 F.

Boiler Efficiency.

Relative Efficiencies of Yorkshire and Lancashire Boilers. Charles Travis. A comparison of these types and details of tests made. 2500 w. Boiler Maker—March, 1910. No. 12228.

Boiler Explosions.

Boiler Explosions. Charles L. Hubbard.

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Cofisiders the causes of boiler explosions and the means taken to prevent them. 1500 w. Elec Rev, N Y—March 12, 1910. No. 12253.

Boiler Failures.

The Diseases of Boilers. A summary of the results of investigations of the Hartford Steam Boiler Inspection & Insurance Co. as given by F. S. Allen in an address before the New England Assn. of Elec. Lgt. Engrs. 3500 w. Eng Rec—March 19, 1910. No. 12367.

Boiler Feeding.

Feeding Water to Steam Boilers. J. E. Terman. Illustrated description of the usual boiler feeds, used in the United States, and the effects produced by them. 2200 w. Power—March 15, 1910. No. 12267.

Operation of Boiler Feed Systems. William F. Fischer. Considers points in the design and operation of feed-water systems for modern condensing and non-condensing plants. 4000 w. Power—March 8, 1910. No. 12170.

Boiler Furnaces.

The Thermal Conductivity of Fire-Clay at High Temperatures. J. K. Clement and W. L. Egy. Investigations to obtain information concerning the loss of heat through the walls of boiler furnaces. Ills. 5500 w. Univ of Ill, Bul 36—Aug. 2, 1909. No. 12535 N.

An Improved Mechanically-Stoked Furnace. Illustrates and describes a system of grates, operated either mechanically or by hand-firing. 1800 w. Prac Engr—Feb. 18, 1910. No. 12056 A.

Boiler Management.

Irregularities in Furnace Fires. Arthur S. Mann. Arrangement favoring the placing of technical men in charge of the fire-room and stokers. 2000 w. Engineering Magazine—April, 1910. No. 12688 B.

CO^2 Percentages and Economical Firing. J. V. Hunter. Explains how carbon dioxide in flue gases was increased by careful firing and variation of draft with load. 2500 w. Power—March 22, 1910. No. 12510.

Boilers.

See Power Generation, under Power and Transmission.

Boiler Troubles.

Unstable Water Lines in Steam Boilers. C. L. Hubbard. Illustrates and describes various sources of trouble in heating boiler operation. 2000 w. Met Work—March 26, 1910. No. 12667.

Boiler Tubes.

Deformations of Fire Tubes (Déformations des Tubes foyers). B. Müller. Translated from the *Zeitschrift des Vereines deutscher Ingenieure*, May 15, 1909. Ills. 4500 w. Rev de Mécan—Feb., 1910. No. 12422 E + F.

Boiler Waters.

Water Supply and Treatment for Power Plant Purposes. William Miller Booth. From a paper before the Am W-Wks. Assn. Discusses soft and hard waters, saline, alkaline and acid waters, and methods of treatment. 4500 w. Munic Engng—March, 1910. No. 12325 C.

Condensers.

The Surface Condenser in Mining Power Plant. W. A. MacLeod. Explains the principles of design as applied to constant condensation, and applies the formulae to mixed plant consisting of constant and intermittent prime movers, giving test data of complex plant. Ills. 10500 w. Inst of Min & Met, Bul. 65—Feb. 10, 1910. No. 12322 N.

The Improvement in Design of Condensing Installations on Board of Sea-Going Vessels. Hans Vogel. Translation of an article on the design of marine condensing installations which appeared in *Zeit für das Gesamte Turbinenwesen*. Ills. 2000 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12698 H.

A New Condenser—Intake Tunnels. R. D. Tomlinson. Illustrated description of a condenser so designed that all the condensing apparatus, exclusive of piping, is placed entirely beneath the turbine and between the foundation columns. 2500 w. Power—March 22, 1910. No. 12509.

Engine Pistons.

The Calculation of Solid Pistons (Die Berechnung der Scheibenkolben). C. Pfleiderer. Mathematical discussion of their design. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 1910. No. 12614 D.

Fuel Purchasing.

Purchase of Coal and Oil by the Cleveland Water Department. E. W. Bemis and C. F. Schulz. Describes methods giving a summary of specifications. Discussion. 2000 w. Pro Am W-Wks Assn—1909. No. 12755 N.

Fuels.

Chemical Data as Related to the Power Plant. S. W. Parr. Discusses the function that chemistry may perform in the study of the fuel problem. 3300 w. Pro Am W-Wks Assn—1909. No. 12756 N.

Bagasse and Bagasse Furnaces. Editorial review of a bulletin recently issued by the Louisiana State Univ. detailing results of a number of tests carried out on actual installations in Louisiana and Cuba. 2500 w. Engng—Feb. 18, 1910. No. 12060 A.

See also Briquetting, under MINING AND METALLURGY, Coal and Coke.

Fuel Testing.

Federal Investigations of Mine Accidents, Structural Materials, and Fuels, at the United States Testing Station, Pittsburg, Pa. Herbert M. Wilson. Explains

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the character of the work and the methods adopted, giving summary of results. Ills. 38500 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12659 E.

Government Investigations and Test of Fuels. Address by Herbert M. Wilson, with discussion. 6000 w. Pro Engrs' Club of Phila—Jan., 1910. No. 12568 D.

The Use and Abuse of Fuels. H. M. Wilson. Discusses the U. S. Government's methods for testing and purchasing fuels. General discussion follows. 9800 w. Pro Am W-Wks Assn—1909. No. 12757 N.

Heat Transmission.

Heat Transmission and Transmitters. A. B. Willits. Describes the construction and principle of the "S and K" corrugated film heater. 1500 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12697 H.

Mechanical Stokers.

See Boiler Furnaces, under STEAM ENGINEERING.

Steam Piping.

Expansion of Pipes. Ralph C. Taggart. Considers methods of caring for expansion in steam piping or other pipes subject to considerable change of temperature. 6000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12658 E.

Thermodynamics.

On the Definition of the Ideal Gas. Edgar Buckingham. Explains the nature and purpose of the definition and its use in thermodynamic reasoning. 5000 w. Bul Bureau of Stand—Feb., 1910. No. 12564 N.

The Second Law of Thermodynamics; Its Basis in Intuition and Common Sense. Prof. W. S. Franklin. An account of this fundamental principle. 8400 w. Pop Sci M—March, 1910. No. 12296 C.

Turbine Efficiency.

Losses in the Blades of Free-Jet Steam Turbines (Verluste in den Schaufeln von Freistrahldampfturbinen). Nikolai Briling. A theoretical discussion and results of experimental investigations. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1910. No. 12611 D.

Turbines.

Elementary Principles of Steam Turbine. William E. Snow. Explains the fundamental principles of commercial impulse turbines and compares them with hydraulic turbines. Ills. 4000 w. Power—March 8, 1910. No. 12168.

A New Turbine. Illustrated detailed description of steam turbines of the so-called combined velocity and pressure type, being manufactured by Dick, Kerr & Co., Ltd. 3000 w. Engr, Lond—Feb. 18, 1910. No. 12064 A.

The Barbegat Steam Turbine (Die Dampfturbine Bauart Barbezat). P. André. Illustrated detailed description of the theory and design. Serial. 1st part. 3300 w. Die Turbine—Feb. 20, 1910. No. 12479 D.

Turbine Tests.

Test of a 15000-KW. Steam-Engine-Turbine Unit. H. G. Stott. R. J. S. Pigott. Gives the reasons for adopting this type of apparatus, with a brief description of the plant and summary of results, with data acquired during tests. Tables and curve sheets. 2500 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12351 F.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Telpherage Systems for Foundries. Alfred Gradenwitz. Illustrates and describes modern German methods of handling raw material in foundry storage yards and its conveyance to the cupola. 1200 w. Foundry—March, 1910. No. 12092.

A Telpherage System for Handling River Traffic. Illustrated description of a handling plant near Memphis, built by the Illinois Central R. R. 1200 w. Eng Rec—Feb. 26, 1910. No. 12034.

Bleichert Electric Aerial Tramways (Bleichertsche Elektrohängebahnen). S. Abt. Describes a number of recent installations in industrial plants. Ills. 3500 w. Schweiz Bau—Feb. 12, 1910. No. 12475 B.

Elektromechanical and Electromagnetic Devices for Electric Aerial Tramways (Elektromechanische und elektromagnetische Einrichtungen für die Zugdeckung und das Windwerk von Motorlaufkatzen bei Elektrohängebahnen). Hans Wettich. A description of the electrical arrangement of tramway carriers. Ills. Serial. 1st part. 1500 w. Elektrotech Rundschau—Feb. 17, 1910. No. 12498 D.

Cableways.

Aerial Coal-Conveying Ropeway at Barnsley Main Colliery. Illustrates and describes an interesting ropeway on the endless running rope system. 700 w. Ir & Coal Trds Rev—March 11, 1910. No. 12507 A.

Car Dumping.

See Freight Cars, under RAILWAY ENGINEERING MOTIVE POWER AND EQUIPMENT.

Coal Handling.

Practical Considerations in Coal Handling for Pumping Plants. S. Bent Russell. Suggestions for determining the best system. General discussion. 2000 w. Pro Am W-Wks Assn—1909. No. 12758 N.

Transport Devices in the Reisholz Central Station (Die Transporteinrichtungen der Zentrale des Rheinisch-Westfälischen Elektrizitätswerkes zu Reisholz). Hubert Hermanns. Illustrated description of the coal-handling equipment. 1700 w. Elektrotech u Maschinenbau—Feb. 13, 1910. No. 12605 D.

See also Coaling Stations, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

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Cranes.

The Jordan Compressed-Air Brake and Coupling for Foundry Cranes (Die Jordan-Druckluftbremse und -Kupplung an Giessereikranen). K. Behrend. Illustrated description and discussion. 1800 w. Giesserei-Zeit—Feb. 15, 1910. No. 12465 D.

Freight Handling.

Economical Freight Transference at Railway Terminals and Shipping Docks. H. McL. Harding. An illustrated study of the situation and a discussion of mechanical systems and their requirements, terminal improvements, etc. 12500 w. Eng News—March 3, 1910. No. 12107.

See also Telpherage, under TRANSPORTING AND CONVEYING.

Industrial Locomotives.

The Electric Storage Battery Locomotive. Warren H. Miller. Gives conclusions based on observations of practical operation in industrial service. Deals with the selection of proper equipment, the care of battery and locomotive, and the facilities for charging. 3500 w. Elec Wld—March 31, 1910. No. 12629.

Lifting Magnets.

Lifting Magnets. Calls attention to points in their design. 600 w. Prac Engr—Feb. 25, 1910. No. 12181 A.

MISCELLANY.

Aeronautics.

New Aeroplanes at Home and Abroad. Illustrates and describes recent types. 3000 w. Sci Am—March 19, 1910. No. 12347.

Aëroplane Stability. G. H. Bryan. An account of the peculiarities of aëroplane stability as deduced from the author's work, and a comparison with Ferber's and Lanchester's methods. 3000 w. Nature—March 3, 1910. No. 12298 A.

The Stability of Flying Machines. Herbert Chatley. Discusses the principles in connection with stability, considering the automatic single-surface glider in the present article. 2000 w. Engng—March 4, 1910. Serial. 1st part. No. 12287 A.

The Sustentation of Aeroplanes (Sur la Sustentation des Aéroplanes). H. Alexandre. Mathematical outline of the theory of the action of the air on plane and curved moving surfaces. 3000 w. Bul Sci d l'Assn des Elèves—Jan., 1910. No. 12405 D.

The International Aero and Motor-Boat Exhibition. An illustrated account of the most striking features of the show. 6500 w. Engng—March 18, 1910. Serial. 1st part. No. 12732 A.

Exhibits at the Aero and Motor-Boat Exhibition at Olympia. Illustrates and describes petrol-electric generators, and two-cycle petrol engines. 2500 w. Engng—March 11, 1910. No. 12396 A.

Letter Mailer.

Automatic Machinery as Used in Office Work. R. S. Bayard. Illustrated description of a machine for mailing letters at the rate of 200 a minute. 2200 w. Am Mach—Vol. 33. No. 9. No. 12122.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

See Fuel Testing, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Alaska.

Controller Bay Coal Field. George Watkin Evans. An illustrated article giving the location, extent, and quality of these coal fields in Alaska, and proposed transportation routes. 4500 w. Mines & Min—March, 1910. No. 12081 C.

Briquetting.

The Fuel-Briquetting Industry. Charles L. Wright. An illustrated discussion of the possibilities and the principal briquetting processes. This first part considers plants, materials, etc. 3000 w. Engineering Magazine—April, 1910. No. 12684.

A Commercial Fuel-Briquette Plant. W. H. Blauvelt. Illustrated description of the briquette-plant of the Solvay Process Co. and the Semet-Solvay Co. at Detroit, Mich., with details of operation. 3500 w. Bul Am Inst of Min Engrs—March, 1910. No. 12693 F.

Coal Cutting.

The Advantages of Machine Mining. Floyd W. Parsons. Compares different types of undercutting machines, discussing various methods of undercutting a coal seam. Ills. 2500 w. Eng & Min Jour—March 19, 1910. No. 12374.

Coke-Oven Effluents.

The Pollution of Streams by Spent Gas Liquors from Coke Ovens and the Methods Adopted for Its Prevention. Dr. H. Maclean Wilson. Abstract of a paper read before the Midland Inst. of Min., Civ., & Mech. Engrs. on the treatment of coke-oven effluent. 3000 w. Col Guard—Feb. 25, 1910. No. 12187 A.

Coke Ovens.

The Mackay-Seymour System of Coke Ovens and By-Products Plants. Illustrates and describes an installation at Skelmanthorpe, Eng. 2300 w. Col Guard—Feb. 25, 1910. No. 12186 A.

Electric Power.

Rules for the Installation and Use of Electricity in Mines. Eustace E. Baker. Abstract of paper before the Manchester

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Geol. & Min. Soc. Suggestions for the amendment of the existing rules in Great Britain. 6500 w. Col Guard—March 18, 1910. No. 12730 A.

England.

Brodsworth Main Collieries. Illustrated description of colliers near Doncaster, England, and their equipment. 2000 w. Ir & Coal Trds Rev—Feb. 25, 1910. No. 12197 A.

Explosions.

Dust-Explosions in Coal Mines. George S. Rice. Information concerning investigations carried out by the Technologic Branch of the U. S. Geological Survey. 1500 w. Bul Am Inst of Min Engrs—March, 1910. No. 12692 F.

The Primero Disaster. R. L. Herrick. Illustrated description of the mines and conditions, and the action of the explosive force. 10500 w. Mines & Min—March, 1910. No. 12083 C.

Explosives.

Permissible Explosives as Used in Coal Mines. J. J. Rutledge. Directions for the intelligent use of the new explosives, and the economy resulting. 5600 w. Eng & Min Jour—March 26, 1910. No. 12668.

Mining.

The Small Coal Question. Discusses the demand of the South Wales miners that payment be made the collier for small coal. 5000 w. Col Guard—March 18, 1910. No. 12728 A.

The Multiple Shift System of Working in Northumberland and Durham. H. F. Bulman. Describes this system and the annoyance from the Eight Hours Act. 2500 w. Col Guard—March 11, 1910. No. 12391 A.

Safety Appliances in German Mines. R. W. Voigt. Information concerning the amount of air required by law; blasting, safety chambers and their equipment. 2400 w. Mines & Min—March, 1910. No. 12082 C.

Peat.

Some Commercial Aspects of Peat as a Source of Chemical Products. Charles A. Davis. Discusses what is being done in Europe to recover valuable by-products from peat, and as a source of producer-gas, and the commercial possibilities for the United States. 7500 w. Ec-Geol—Jan., 1910. No. 12534 D.

Safety Lamps.

Various Types of Safety Lamps. J. B. Marsaut. Abstract translation from the *Bul. de l'Indus. Min.* Illustrates and describes types, considering their comparative safety. 2500 w. Sci Am Sup—March 12, 1910. No. 12226.

Acetylene Safety Lamps (Azetylen-Sicherheitslampen). Herr Beyling. Describes a number of types and discusses their advantages. Ills. 6000 w. Glückauf—Feb. 19, 1910. No. 12468 D.

Siberia.

Coal-Mining Methods in Siberia. Information from a paper by Robert M Percy concerning methods of working, general conditions, etc. 1500 w. Eng & Min Jour—March 19, 1910. No. 12375.

COPPER.

Chile.

The Copper Mines and Smelting Works of Naltagua, Santiago, Chile. F. A. Sundt. Abstract translation. Describes the mines, smelting works, etc. 2000 w. Min Jour—March 19, 1910. No. 12726 A.

Converters.

Recent Patents for Basic-Lined Copper Converters. Richard H. Vail. An illustrated review of the Peirce and Smith converter patents. 2000 w. Eng & Min Jour—March 12, 1910. No. 12262.

Michigan.

The Michigan Copper Mines and Methods. R. B. Brinsmade. Map and description of the geology, topography and development. Ills. 3500 w. Min Wld—March 12, 1910. Serial. 1st part. No. 12259.

Montana.

See Ore Deposits, under MISCELLANY.

Nevada.

The Bristol Mines. Stephen L. Goodale. Illustrated description of a typical desert copper-silver mine near Pioche, Nev. 3000 w. Mines & Min—March, 1910. No. 12090 C.

The Mines of the Ely District of Nevada. Leroy A. Palmer. An illustrated review of this old gold and silver district which has recently become one of the greatest copper producing districts of the country. 5000 w. Min Wld—March 5, 1910. No. 12158.

Report to Stockholders of Ely Central Copper Co. Walter Harvey Weed. Illustrated description of the property examined, stating the conclusions reached. 3000 w. Min Wld—Feb. 26, 1910. No. 12039.

See also Copper, under ORE DRESSING AND CONCENTRATION.

Refining.

Sampling Anode-Copper, With Special Reference to Silver-Content. William Wraith. An investigation of methods used at the Washoe smelter, Anaconda, Mont. 1200 w. Bul Am Inst of Min Engrs—March, 1910. No. 12691 F.

Smelter Fumes.

Elimination of Smelter Fume. Leroy A. Palmer. Information concerning the successful neutralization of the fume at the plant of the U. S. Smelting Co., Midvale, Utah. Ills. 5000 w. Mines & Min—March, 1910. No. 12088 C.

Sprague Process for Treating Furnace Gases. C. B. Sprague. Describes this process which is used successfully at Midvale, Utah. 2000 w. Eng & Min Jour—March 5, 1910. No. 12156.

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Smelting.

The Uses and Abuses of Small Smelting Plants. Herbert Lang. Discusses causes of failure, and some that may be avoided, the mechanical features and the smelting mixture. 4500 w. Eng & Min Jour—Feb. 26, 1910. No. 12035.

GOLD AND SILVER.

Alaska.

See Dredging, under GOLD AND SILVER.

Australia.

Deep Lead Mining in New South Wales. E. W. Nardin. Sketch plan, and description of the Main Ridge auriferous deep lead system near Rockley (N. S. W.). 1800 w. Aust Min Stand—Feb. 9, 1910. No. 12305 B.

Mount Flora Gold and Mineral Field. Lionel C. Ball. An illustrated description of the geography, geology, ore deposits, mining, etc. 10500 w. Queens Gov Min Jour—Feb., 1910. Serial. 1st part. No. 12303 B.

California.

Hoag District, California. Norman C. Stines. Information concerning the geology, ore deposits, development, etc. Ills. 2500 w. Min & Sci Pr—March 12, 1910. No. 12336.

See also Placers, under GOLD AND SILVER.

Cyaniding.

Commercial Sodium and Potassium Cyanide. W. J. Sharwood. Considers relative merits as shown by chemical analysis, errors due to incorrect standards, etc. Bibliography. 3000 w. Eng & Min Jour—March 19, 1910. No. 12373.

Notes on the Precipitating Effects of Substances Containing Various Forms of Carbon and Cellulose on Cyanide Solutions Containing Gold and Silver. A. J. Clark and W. J. Sharwood. Gives results of a series of experiments and observations, with other information. 3000 w. Jour Chem, Met, & Min Soc of S Africa—Jan., 1910. No. 12276 E.

Cyanidation of Concentrate. A. E. Drucker. Illustrates and describes a combined air-agitator and continuous leaching vat, explaining its economy and efficiency for treating high grade slime. 2000 w. Min & Sci Pr—March 19, 1910. No. 12631.

The Silver Cyanide Mill of the San Rafael of Anexas Co., Pachuca. E. Girault. Read before the Inst. Mexicano de Mines y Met. Illustrated description of the mills, their equipment, and the treatment. 1200 w. Met & Chem Engng—March, 1910. No. 12204 C.

Dredging.

Dredging Nome Beach Sands. Illustrates and describes a type of dredge that is saving gold from underwater sands. 1800 w. Mines & Min—March, 1910. No 12087 C.

Submarine Gold Dredging at Nome, Alaska. Elmer E. Carey. Discusses plans for dredging the rich fields of the Arctic Ocean along the Nome coast. 1500 w. Min Wld—March 19, 1910. No. 12382.

Pony Dredges in Alaska. William H. Washburn. A brief review of plans tried in adapting machinery to placer mining. Ills. 2000 w. Min & Sci Pr—March 5, 1910. No. 12257.

Mexico.

Prospecting in Chihuahua. R. H. Burrows. Describes this important mining region, giving a map showing the geology of this district. 1500 w. Min & Sci Pr—March 12, 1910. No. 12337.

Nevada.

The Montana-Tonopah Mine and Mill, Nevada. A. H. Martin. Illustrated detailed description. 2000 w. Min Wld—March 12, 1910. No. 12260.

Reopening of the Mexican Mine, Comstock Lode. Whitman Symmes. An illustrated account of the devolopment and description of the geology. 2500 w. Min & Sci Pr—March 19, 1910. No. 12632.

Nicaragua.

Piz-Piz District, Nicaragua. W. A. Connelly. Map and brief account of this gold mining district. 2000 w. Min & Sci Pr—March 5, 1910. No. 12256.

Norway.

Kongsberg Silver Mines, Norway. H. L. Lawrence. An account of one of the oldest mining centers in Europe, where native silver is found in persistent quantities. 2500 w. Min Jour—March 5, 1910. No. 12282 A.

Placers.

Dredging and the Sampling of Placer Ground. A. P. Rogers. Brief description of methods of testing and preliminary sampling. 2000 w. Eng & Min Jour—March 12, 1910. No. 12261.

Santa Clara River Placers. Claude E. Jamison. Brief account of this part of California, said to be the district where gold was first discovered. 1500 w. Min & Sci Pr—March 5, 1910. No. 12258.

IRON AND STEEL.

Bessemer Converters.

The Design of Basic Bessemer Converters (Einige Gesichtspunkte für die Konstruktion der Thomasbirne). W. G. Gillhausen. A review of progress since 1875. Ills. 3200 w. Stahl u Eisen—Feb. 23, 1910. No. 12463 D.

Blast-Furnacce Gas.

Recent Installations for the Utilization of Blast-Furnace and Coke-Oven Gases (Récentes Installations pour l'Utilisation des Gaz de haut Fourneau et de Fours à Coke). A brief review of gas-engine progress in Germany. Ills. 1800 w. L'Elecn—Feb. 12, 1910. No. 12429 D.

Blast-Furnace Practice.

Advantages of Enriched Air Blast. Jos. W. Richards. The effect air enriched in oxygen can have upon the working of a

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blast furnace is considered. 1000 w. Met & Chem Engng—March, 1910. No. 12203 C.

The Combustion-Temperature of Carbon and Its Relation to Blast-Furnace Operation. Clarence P. Linville. A study of the relations of blast-temperature, moisture-content, and combustion temperature. 3300 w. Bul Am Inst of Min Engrs—March, 1910. No. 12694 F.

Blast-Furnace Slags.

Black and Blue Blast-Furnace Slags (Schwarze und blaue Eisenhochofenschlacken). Hans Fleissner. An important investigation of the coloring of slags. Ills. Serial. 1st part. 2800 w. Oest Zeitschr f Berg u Hüttenwesen—Feb. 12, 1910. No. 12466 D.

Blowing Engines.

A Notable Gas Engine Installation. Brief illustrated description of the Tod gas-driven blowing engines at the Carnegie Steel Co.'s works at Youngstown, Ohio. 600 w. Ir Age—March 17, 1910. No. 12301.

British Columbia.

Iron Ore Deposits of Vancouver and Texada Islands, British Columbia. Einar Lindeman. Description of districts. 5 maps. 9000 w. Can Dept of Mines, 1910—No. 47. No. 12528 N.

Cowper Stoves.

Calculation of Hot-Blast Stoves Based on the Conductivity of Refractory Bricks (Le Calcul des Appareils à Air chaud basé sur la Conductibilité des Briques réfractaires). B. Osann. An exhaustive treatment. Ills. 8500 w. Rev de Métal—Feb., 1910. No. 12414 E + F.

Dry-Air Blast.

Drying Blast with Calcium Chloride. Illustrates apparatus and describes the process. 1500 w. Ir & Coal Trds Rev—March 11, 1910. No. 12505 A.

Electrometallurgy.

The Electric Furnace, with Special Reference to the Manufacture of High-Class Steel. Joh. Harden. Read before the Rugby Engng. Soc. Reviews the development of the electric furnace as used for metallurgical purposes. 4200 w. Mech Engr—Feb. 25, 1910. No. 12185 A.

The Electric Furnace. J. Harden. Abstract of a paper read before the Rugby Engng. Soc. Discusses the advantages and disadvantages of various types, giving typical results, metallurgical and financial, and refers to the effect of power factor. 2200 w. Elect'n, Lond—March 18, 1910. No. 12717 A.

The Electric Production of Iron from Iron Ore. Report by Lars Yngström on experiments made at Domnarfvet Ironworks, Sweden, to find a suitable reduction furnace for the continuous production of pig iron. Ills. 2000 w. Engr, Lond—Feb. 25, 1910. Serial. 1st part. No. 12196 A.

Ferro-Alloys.

Manufacture and Transport of Ferrosilicon. Useful and interesting information from a report issued by the British Local Government Board, concerning the nature of the gases evolved and the possibilities of preventing danger. Ills. 4000 w. Met & Chem Engng—March, 1910. No. 12207 C.

Germany.

The Development of the Iron Industry in Germany (Die Entwicklung der Eisenindustrie in Deutschland). W. Mathesius. A historical and statistical review. Ills. 6500 w. Stahl u Eisen—Feb. 9, 1910. No. 12456 D.

Prices of Raw and Finished Materials in Germany from 1887 to 1909. A series of charts showing prices in the German iron industry. Stahl u Eisen—Feb. 16, 1910. No. 12461 D.

Ingots.

Thermal Treatment of Steel Ingots. J. F. Springer. Illustrated discussion of methods aiming to prevent pipes and segregation. 1800 w. Sci Am—March 26, 1910. No. 12644.

Quebec.

Canadian Iron Ores Along the Ottawa and Gateneau Rivers. Editorial discussion of these ore deposits. 2000 w. Engng—March 18, 1910. No. 12734 A.

Rolling Mills.

A Three-High Steel Rolling Mill. R. L. Cochran. Describes a type used for rolling rails, structural shapes, plates, flats, rounds, square or the like. Ills. 1800 w. Sib Jour of Engng—March, 1910. No. 12552 C.

Recent Roll Trains (Ueber neuere Walzenstrassen). Describes recent plants of German origin in various parts of the world. Ills. 3800 w. Stahl u Eisen—Feb. 23, 1910. No. 12462 D.

A Study of Rolled Material at the Various Stages of Manufacture (Untersuchung von Walzmaterial in den verschiedenen Verarbeitungsstufen). A report of tests at the Aachen Technical High School. Ills. 1700 w. Stahl u Eisen—Feb. 16, 1910. No. 12460 D.

Steel Works.

The Hungarian State Diosgyör Steel Works. J. B. Van Brussel. Illustrated description of a European state-operated industrial establishment. 2000 w. Ir Trd Rev—March 17, 1910. No. 12332.

LEAD AND ZINC.

Missouri.

Operations of the Doe Run Lead Company. Albert H. Fay. Describes the mining and milling methods. A 2000-ton concentrating plant; producer-gas engines and electric generators, and compressed air haulage. Ills. 2500 w. Eng & Min Jour—March 9, 1910. No. 12372.

Reclaiming Zinc and Lead Ores. Lucius

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L. Wittich. An account of methods of stripping worked out mines in the Joplin district, and the reworking of tailings. Ills. 3000 w. Mines & Min—March, 1910. No. 12089 C.

Geology of Southeast Missouri Lead District. H. A. Wheeler. A review of Dr. E. R. Buckley's report on this district. 2000 w. Eng & Min Jour—Feb. 26, 1910. No. 12038.

Zinc Smelting.

Use of Carbonaceous Filters in Smelting of Zinc. C. O. Bannister. Read before the Inst. of Metals, London. Describes the Hopkins' process, stating the advantages claimed. 2000 w. Min Wld—March 5, 1910. No. 12160.

Recovery of Zinc from the Zinc Slags of the Lower Harz Smelters (Die Gewinnung des Zinks aus den Zinkhaltigen Schlacken der Unterharzer Hüttenbeitriebe). Herr Pape. A brief description of a recently developed process for utilizing zinc slags. 2000 w. Glückauf—Feb. 19, 1910. No. 12469 D.

MINOR MINERALS.

Manganese.

Cost of Mining Manganese Ore in India. Abstracted from a report on "The Manganese Ore Deposits of India" by L. Leigh Fermon. Remarks applying particularly to the Central Provinces. 4500 w. Ir & Coal Trds Rev—March 11, 1910. No. 12504 A.

Marble.

Some Remarkable Fine Marble Quarries in Colorado. Arthur Lakes. Information concerning remarkable deposits comparing favorably with the finest in Europe. Ills. 1500 w. Min Wld—March 19, 1910. No. 12381.

Oil.

Early Waste of Petroleum. Xeno W. Putnam. An account of the wasteful methods employed in the oil industry of western Pennsylvania in its early history. Ills. 2000 w. Mines & Min—March, 1910. No. 12086 C.

Oil Fields of Peru. Lindell T. Bates. Description and information concerning the oil beds and their development. Ills. 1200 w. Yale Sci M—March, 1910. No. 12648 C.

Joint Report on the Bituminous, or Oil-Shales of New Brunswick and Nova Scotia. Also, on the Oil-Shale Industry of Scotland. Part I. Economics. Part II. Geology. R. W. Ells. Ills. 36000 w. W Can Dept of Mines, 1910—Nos. 55 and 1107. No. 12529 N.

Vanadium.

Vanadium. Its Occurrence, Preparation and Uses. Information concerning vanadium minerals and their distribution, extraction and industrial uses. 3000 w. Bul Imp Inst—Vol. VII. Nov. 4, 1909. No. 12297 C.

MINING.

Accidents.

Fatal Accidents in American Metal Mines. Frederick L. Hoffman. A comparison of international statistics, and calling attention to the need of effective legislation. 2500 w. Eng & Min Jour—March 5, 1910. No. 12155.

Drills.

Rock Drills and Their Latest Development (Die Gesteinbohrmaschinen und ihre neuere Entwicklung). Fr. Herbst. A review of machine mining methods, rock drills and their applications, etc. Ills. Serial. 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 1910. No. 12613 D.

Rock Drill Bits. T. H. Proske. On the selection and treatment of the bits. Ills. 2300 w. Min & Sci Pr—March 5, 1910. No. 12255.

Earth Shakes.

Earth-Shakes in Mining Districts. Charles Davison. Describes their characteristic features and gives a theory of their origin. 2000 w. Min Jour—March 12, 1910. No. 12388 A.

Electric Hoisting.

Large Electric Hoisting Plants. Wilfred Sykes. Describes methods used by the author for the determination of load diagrams and also the characteristics of balancing systems and their economy. Ills. 7000 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12704 F.

Electric Power.

The Causes and Means of Preventing Electrical Accidents in Mines. An inquiry undertaken by the Inst. of Min. Elec. Engrs. This first article discusses electric shocks. 1600 w. Col Guard—Feb. 18, 1910. Serial. 1st part. No. 12059 A.

Engineering Ethics.

Professional Ethics. Victor G. Hills. Suggestions offered as a contribution to the discussion invited by John Hays Hammond. 5000 w. Bul Am Inst of Min Engrs—March, 1910. No. 12690 F.

Hoisting.

Stationary versus Moving Hoisting Plants. J. F. Jackson. A discussion of open-cut mining. 1200 w. Eng & Min Jour—March 5, 1910. No. 12157.

Hoisting Cages.

New Safety Cage at Mount Morgan (Q.). Brief illustrated description of a cage and safety gear for transporting men and supplies at the shaft of the Mount Morgan G. M. Co. (Q.). 500 w. Aust Min Stand—Feb. 2, 1910. No. 12304 B.

Hoisting Engines.

The "A. B. S." Brake for Winding Engines. Illustrated description. 1000 w. Ir & Coal Trds Rev—March 11, 1910. No. 12508 A.

Mine Cars.

Ball and Roller Bearings for Mine Cars (Kugel- und Rollenlagerradsätze für För-

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derwagen). Herr Schulte. Discusses the reduction in friction and the economy. Ills. 2000 w. Glückauf—Feb. 19, 1910. No. 12470 D.

Mine Locomotives.

See Industrial Locomotives, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Mine Roofs.

The Strength of Mine Roofs. R. Dawson Norris Hall. Considers the behavior of the mine roof under its own load, the strength of the materials composing it, the action of the forces that cause breaks. Ills. 2500 w. Mines & Min—March, 1910. No. 12084 C.

Problems.

Application of Descriptive Geometry to Mining-Problems. Joseph W. Roe. Explains a number of useful applications. 3500 w. Bul Am Inst of Min Engrs—March, 1910. No. 12689 F.

Quarrying.

Cornish Granite. Illustrates and describes quarries at Penryn, near Falmouth, Cornwall. 1500 w. Quarry—March, 1910. No. 12191 A.

Shafts.

The Strength of Concrete and Reinforced Concrete Shaft Linings (Die Festigkeit von Schachtausmauerungen aus Beton und Eisenbeton). E. Elwitz. Mathematical. Ills. 2500 w. Deutsche Bau—Feb. 16, 1910. No. 12473 B.

Shaft Sinking.

Methods and Cost of Sinking the Brier Hill Concrete-Lined Shaft, Michigan. Arranged from a paper by William Kelley, in the Pro. of the L. Superior Min. Inst. Plans and description. 2000 w. Engng-Con—March 2, 1910. No. 12099.

Signal Systems.

Signalling Instruments for Mines. Illustrates and describes a system installed by the Adnil Elec. Co., Ltd. 1500 w. Col Guard—March 11, 1910. No. 12392 A.

Sorting.

Sorting: An Economic Problem on the Rand. C. O. Schmitt. Discusses whether it is possible to sort out barren rock only; and, if so, whether it can be done at a profit. Also discussion. Ills. 8500 w. Jour S African Assn of Engrs—Feb., 1910. No. 12711 F.

Stoping.

Stoping Methods in Mines of Ducktown Basin. John Tyssowski. Underhand stoping is generally used, and small pillars of ore left for support. Ills. 1500 w. Eng & Min Jour—Feb. 26, 1910. No. 12037.

Ventilation.

The New Ventilation Installations at the Mines of the Clausthal District (Die neuen Ventilatoranlagen auf den Gruben der Königl. Berginspektion Clausthal). Herr Saubrey. Describes a Rateau turbo-fan installation. Ills. 2000 w. Glückauf—Feb. 5, 1910. No. 12467 D.

ORE DRESSING AND CONCENTRATION.

Classification.

See Tube Mills, under ORE DRESSING AND CONCENTRATION.

Coal Separators.

A New Separator for the Removal of Slate from Coal. V. H. Wilson. Reviews methods and machines used in removing slate and handling coal with as little waste as possible, and describes a new separator and its operation. 1500 w. Yale Sci M—March, 1910. No. 12649 C.

Copper.

The Steptoe Concentrating Plant, Nevada. Leroy A. Palmer. Illustrated detailed description of the plant and its operation. 4500 w. Min Wld—March 19, 1910. No. 12380.

Filters.

The Oliver Continuous Filter at Minas del Tajo. G. A. Tweedy and R. L. Beals. Illustrates and describes the construction and operation of these filters. 1000 w. Eng & Min Jour—March 5, 1910. No. 12154.

Stamp Mills.

The Development of Heavy Gravitation Stamps. Remarks by C. O. Schmitt on the paper by W. A. Caldecott. Ills. 5000 w. Inst of Min & Met, Bul. 65—Feb. 10, 1910. No. 12321 N.

Tube Mills.

Pulp Classification and Tube Mill Efficiency. From a report by V. B. Sherrod on some features of research work at the Guerrero Mill, Pachuca, Mex., particularly in pulp classification and the efficiency of tube-mill work. 1500 w. Met & Chem Engng—March, 1910. No. 12208 C.

Zinc Milling.

Horwood Process for Separating Zinc Sulphides. Donald Clark. Explains the principle of the process. Ills. 1200 w. Eng & Min Jour—Feb. 26, 1910. No. 12036.

MISCELLANY.

India.

The Economic and Productive Minerals of British India. Abstract of a lecture by Mr. W. H. Pickering, before the Birmingham Univ. Min. Soc. 1200 w. Col Guard—March 4, 1910. No. 12286 A.

Ore Deposits.

The Fractional Precipitating of Sulphides. Roger C. Wells. An experimental study, discussing results. 3000 w. Ec-Geol—Jan., 1910. No. 12530 D.

Oxidation of Sulphides. H. A. Buchler and V. H. Gottschalk. An account of experiments to determine whether or not marcasite and pyrite are the only sulphides acting as an accelerator of oxidation. 2000 w. Ec-Geol—Jan., 1910. No. 12533 D.

Superficial Alteration of the Butte Veins. Reno H. Sales. Describes the character of the outcrops of the Butte copper veins. 2200 w. Ec-Geol—Jan., 1910. No. 12531 D.

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RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signaling.

Railway Signaling in America. J. S. Hobson. Treats only of visual signals for train control. Ills. 3500 w. Cassier's Mag—March, 1910. Special No. No. 12517 D.

Power Railway Signaling. J. F. Gairus. An illustrated account of current British practice. 6500 w. Cassier's Mag—March, 1910. Special No. No. 12518 D.

Studies in Circuits as Applied to Signaling. James H. Cormick. An illustrated series of lessons in the development of the circuits used in railway signaling. 3500 w. Sig Engr—March, 1910. Serial. 1st part. No. 12341.

Foreign Current and Its Effect on Track Circuits. Describes conditions often encountered in automatic signal work and means of preventing interference with signal operation. Ills. 1000 w. Sig Engr—March, 1910. No. 12342.

Lightning Arresters for Signal Apparatus. A. G. Wilson. Discusses the principles of lightning arrester design for signal service. 2000 w. Sig Engr—March, 1910. No. 12338.

Standard Rules and General Instructions for the Guidance of Foremen on Signaling and Interlocking Construction. R. A. Becker. 2000 w. Sig Engr—March, 1910. No. 12339.

The Multiple Unit Electric Interlocking Machine. Illustrated description of the design and operation. 1800 w. Sig Engr—March, 1910. No. 12340.

Cullybackey Interlocking and Tyer's Tablet. Illustrated description of the signaling at a typical station on a single-track railway in Ireland. 1200 w. Ry Age Gaz—March 25, 1910. No. 12642.

Signals.

Luminous Repeating or Advance-Indicating Railway Signals. Illustrated description of signals in use on the high-speed Brussels-Antwerp line, as a safeguard during fogs. 800 w. Eng News—March 10, 1910. No. 12216.

Train Despatching.

Train Despatching by Telephone. C. H. Gaunt. An account of its successful use on the A., T. & S. F. Ry. with general remarks. 1500 w. Elec Rev, N Y—March 12, 1910. No. 12254.

Train Speed.

Determination of Train Speed Without Measuring Instruments (Bestimmung von Fahrgeschwindigkeitenohne Messapparte). Hans A. Martens. An outline of a satisfactory method. 2000 w. Glasers Ann—Feb. 1, 1910. No. 12482 D.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Losses of Air Pressure. A general explanation of losses in the use of compressed air, and the effect on air brakes. 2000 w. Ry & Loc Engng—March, 1910. No. 12115 C.

Final Tests with the Automatic Vacuum Brake for Freight Trains (Schlussversuche mit der automatischen Vakuum-Güterzug-Schnellbremse). A final report on the tests carried out by the Austrian Government. Ills. Serial. 1st part. 9000 w. Glasers Ann—Feb. 1, 1910. No. 12480 D.

Car Maintenance.

Maintenance Cards. From a paper by R. W. Burnett, read before the Canadian Ry. Club. Describes the maintenance regulation cards used by the Canadian Pacific Ry. 2500 w. Ry Age Gaz—March 18, 1910. No. 12345.

Electrification.

The Electrification of the Lapland Railway. Editorial on the impending electrification of an important Swedish State Railway through Lapland, built originally for the transport of iron ore. 1500 w. Engng—March 11, 1910. No. 12398 A.

Electric Traction. George Gibbs. From a report to be presented before the Int. Ry. Cong. Discusses electric locomotives, the first cost of electrification, cost of operation, with general remarks. 4000 w. Ry Age Gaz—March 25, 1910. No. 12643.

The Cost of Electric Operation of Steam Railways. Concluding portion of a paper by George Gibbs, in the *Bul. of the Int. Ry. Cong.* for Jan., 1910. Deals with the design of electric locomotives and with the first cost and cost of operation of electrified steam railways. 4000 w. Eng News—March 31, 1910. No. 12776.

Freight Cars.

Handling of Bulk Railway Freight (Die Verladung von Massengütern im Eisenbahnbetrieb). Herr Schwabe. Discusses types of hopper cars and car-dumping devices. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 26, 1910. No. 12617 D.

Lighting Cars.

Benzin-Electric Motor Car for Lighting Purposes on the Swiss Railways (Selbstfahrender benzin-elektrischer Beleuchtungswagen der S. B. B.). M. Messer, Describes a car containing a lighting generator driven by a benzin motor used for tunnel examinations, illuminating scenes of accidents, etc. Ills. 1800 w. Schweiz Bau—Feb. 26, 1910. No. 12478 B.

Locomotive Boilers.

Notes on Locomotive Boiler Failures. J. H. Heltzel. Illustrated discussion of

We supply copies of these articles. See page 317.

failures due to faulty design. 2000 w. March, 1910. No. 12230.

Locomotive Crank Axles.

A Three-Part Crank Axle (Dreiteilige Kurbelachse). Describes a novel type of crank axle on the locomotives of the Austrian State Railways. Ills. 1500 w. Glasers Ann—Feb. 1, 1910. No. 12481 D.

Locomotive Fuels.

Oil Burning on Freight Locomotives. H. B. MacFarland. A report of practical experience with liquid fuel in America. Ills. 3000 w. Cassier's Mag—March, 1910. Special No. No. 12525 D.

Locomotive Operation.

Supervision Tending to Economy in the Operation of Locomotives. J. R. Alexander. Discusses methods for obtaining efficiency in the operation of locomotives, the education for the service, examinations, fuel economy, care of tools, etc. Discussion. 17000 w. Pro Ry Club of Pittsburgh—Jan. 28, 1910. No. 12569 C.

Locomotive Power.

Tractive Effort, Power and Speed in Steam Locomotives (Ueber Zugkräfte, Leistungen und Geschwindigkeiten bei Dampflokomotiven). G. Lanz. A discussion of the relation between the three characteristics. Ills. 3600 w. Schweiz Bau—Feb. 19, 1910. No. 12477 B.

Locomotives.

Modern High-Speed Locomotives. J. F. Cole. An illustrated review of current American practice. 5500 w. Cassier's Mag—March, 1910. Special No. No. 12513 D.

Compounding and Superheating in Horwich Locomotives. George Hughes. Discusses the economy of the compound over the simple engine, and of the superheater over the non-superheater. Ills. 7000 w. Inst of Mech Engrs—March 17, 1910. No. 12727 N.

Construction and Working of Balanced Compound Locomotives in Hungary. Charles R. King. Gives data from tests made, showing the extraordinary pulling capacity with heavy train loads, at high speeds. Ills. 4000 w. Mach, Ry Ed—Jan., 1910. No. 12271 C.

Development of the Mallet Locomotive. Grafton Greenough. Explains how this locomotive differs from common types, reviewing its development. Ills. 4000 w. Jour Fr Inst—March, 1910. No. 12749 D.

The Mallet Locomotive in Service. Editorial discussion of this machine and its operation, concluding that it is economical and satisfactory. 1300 w. Ry Age Gaz—March 11, 1910. No. 12247.

An Experimental Mallet Articulated Locomotive. G. I. Evans. Illustrated detailed description of a design for the Canadian Pacific Railway, constructed under the direction of H. H. Vaughan. 5500 w. Am Engr & R R Jour—March, 1910. Serial. 1st part. No. 12167 C.

A Locomotive with the Cab Over the Pilot. Illustrated description of a Mallet compound for the So. Pacific Ry. 400 w. Eng News—March 10, 1910. No. 12212.

Passenger and Freight Power for the Chicago Great Western. Illustrated descriptions of 4-6-0 passenger engine and 2-8-0 freight engine. 1000 w. Ry & Loc Engng—March, 1910. No. 12117 C.

British Express Locomotives. John Farquharson M'Intosh. Twenty-five illustrations of high speed passenger engines in Great Britain, with descriptive notes and information. 2000 w. Cassier's Mag—March, 1910. Special No. No. 12522 D.

Central South African Mallet Compound. Illustrated description of an engine designed for a 3 ft. 6 in. gauge. 1000 w. Ry & Loc Engng—March, 1910. No. 12113 C.

Mogul Locomotives for the Tientsin-Pukow Railway, China. Illustrated descriptions of engines for general road service, built in America. 900 w. Ry Age Gaz—March 4, 1910. No. 12125.

Some Recent Designs of Locomotives for Service on Continental Railways. Albert H. Bone. Illustrates and describes engines from German, French, Swiss, and Belgian works. 15000 w. Cassier's Mag—March, 1910. Special No. No. 12524 D.

Heavy Express Locomotives for French Mediterranean Railways. Charles R. King. Illustrates and describes the Henry and the De Glehn types. 2500 w. Mach, Ry Ed—March, 1910. No. 12274 C.

High-Speed Compound Locomotives with Three Coupled Axles and 1.9-Mètre Driving Wheels on the Royal Portuguese Railways (Les Locomotives compound à grande Vitesse à trois Essieux couplés et à Roues Motrices de 1.9 m. de la Compagnie Royale des Chemins de Fer Portugais). Henri Lavialle d'Anglards. Illustrated description and report of performance. 2000 w. Rev Gen d Chemins Fer—Feb., 1910. No. 12421 G.

Locomotive Testing.

Reading Indicator Diagrams. An explanation with typical diagram. 1000 w. Ry & Loc Engng—March, 1910. No. 12114 C.

Passenger Cars.

British Railway Coaches for South America. Illustrates and describes two special saloon coaches for exhibition at the Buenos Ayres Centenary Exhibition. 1000 w. Engr, Lond—March 18, 1910. No. 12744 A.

Composite Corridor Brake Carriage; Cambrian Railways. Illustrated description of a recent design. Plate. 700 w. Engng—March 4, 1910. No. 12289 A.

Refrigeration.

The Pre-Cooling Plant of the Southern Pacific at Roseville, Cal. Illustrated description of a plant built for the Pacific

We supply copies of these articles. See page 317.

Fruit Express Co. for precooling California fruits for shipment east. 1200 w. Ry Age Gaz—March 18, 1910. No. 12344.

Shops.

The Equipment of Railway Workshops. G. H. Burrows. Illustrates and describes workshop arrangements and machine tools. 5000 w. Cassier's Mag—March, 1910. Special No. No. 12527 D.

Locomotive Building at Altoona. Ralph E. Flanders. Illustrated detailed description of shop practice at the Juniata shops, especially the making of main and side rods. 5000 w. Mach, Ry Ed—Feb., 1910. No. 12272 C.

Car Shops, Old and New. Discusses the change in system that has been generally effected. 1800 w. Ry Age Gaz—March 4, 1910. No. 12128.

The Empalme Shops, Southern Pacific Railroad of Mexico. Plan and illustrated description of the buildings. 2000 w. Eng Rec—March 12, 1910. No. 12244.

Sleeping Cars.

Sleeping Cars of Radically New Design for the Illinois Traction System. Illustrated detailed description of the constructional features of new sleeping cars for electric railway service, showing improvements in both arrangements and car body design. 2500 w. Elec Ry Jour—March 19, 1910. No. 12333.

Springs.

The Design of Heavy Helical Springs for Railroad Cars. Egbert R. Morrison. Gives derivation of formulae with parallel examples, showing the ease of application. Ills. 800 w. Mach, Ry Ed—Jan., 1910. No. 12270 C.

Train Lighting.

The Necessity of Introducing Electric Lighting in Railway Trains (Ueber die Notwendigkeit der Einführung der elektrischen Beleuchtung in den Eisenbahnwagen). J. Seidner. Emphasizes the safety of electric lighting and compares the cost with that of gas. Ills. 2800 w. Elektrotech u Maschinenbau—Feb. 20, 1910. No. 12623 D.

Improvements Effected in the System for Simultaneous Lighting of Gas Lamps on the Eastern Railway of France (Note sur les Perfectionnements apportés au Système d'Allumage instantané des Trains éclairés à l'Incandescence par le Gaz en Essai à la Compagnie des Chemins de Fer de l'Est). Describes in detail an electrical system. Ills. 5500 w. Rev Gen d Chemins de Fer—Feb., 1910. No. 12420 G.

Train Resistance.

New Rules for Computing Train Resistance. Abstract of a monograph issued by the American Locomotive Co., with editorial remarks. 1500 w. Eng News—March 10, 1910. No. 12221.

Wheels.

Car Wheels. George L. Fowler. On the evolution of the iron and steel wheel. Ills. 4000 w. Cassier's Mag—March, 1910. Special No. No. 12516 D.

NEW PROJECTS.

Australia.

The Trans-Continental Railway of Australia. Map and information concerning this proposed line. 2000 w. Engng—March 11, 1910. No. 12394 A.

Hudson Bay Railway.

The Hudson Bay Railway Project. Maps and discussion of the proposed line and the possible benefits, traffic probabilities and related subjects. 2000 w. Eng News—March 3. 1910. No. 12108.

The Hudson Bay Railway. Map, and information concerning the proposed line to reach Hudson Bay. Ills. 2200 w. Eng Rec—March 12, 1910. No. 12240.

Western Pacific.

Construction of the Western Pacific Ry. Illustrated detailed description of the construction of this extension of the Gould system from Salt Lake City to the Pacific Coast, at San Francisco. 7500 w. Ry & Engng Rev—March 12, 1910. No. 12263.

PERMANENT WAY AND BUILDINGS.

Bridge Inspection.

Railway Bridge Inspection and Erection. Abstract of appendices to the report of the Committee on Iron and Steel Structures, presented at meeting of the Am. Ry. Engng. & Main. of Way Assn. 2500 w. Eng News—March 24, 1910. No. 12586.

Bridges.

See under CIVIL ENGINEERING, BRIDGES.

Coaling Stations.

Railway Fuel Supply. Raffe Emerson. An illustrated discussion of fuel handling at railway coaling stations, the cost, etc. 2500 w. Cassier's Mag—March, 1910. Special No. No. 12526 D.

Construction.

The Construction of the Ninth Division (Hills Section) of the Assam-Bengal Railway. Thomas Richard Nolan. General description of the physical features, geology, etc., with drawings and detailed description of the construction work. 10000 w. Inst of Civ Engrs, No. 3588—1909. No. 12593 N.

Stuartstown Narrow-Gauge Railway, Natal. Walter Sweetman. Illustrations and description of the construction of a 2-foot-gauge railway across the south of Natal, through exceptionally rough country. 3000 w. Inst of Civ Engrs, No. 3803—1909. No. 12594 N.

Elevated Railways.

Revision of Oak Park Elevated at Entrance to New North Western Terminal, Chicago. Explains conditions that made necessary the raising of the elevated structure, giving illustrated description of the work. 1000 w. Ry Age Gaz—March 18, 1910. No. 12346.

We supply copies of these articles. See page 317.

Grade Reduction.

Heavy Regrading by Means of Hydraulic Sluicing at Seattle, Wash. George Holmes Moore. An illustrated account of the lowering of the section known as Denny Hill. 3000 w. Eng News—March 31, 1910. No. 12774.

Narrow-Gauge.

See Construction, under PERMANENT WAY AND BUILDINGS.

Rack Railways.

Mountain and Rack Railways. Roman Abt. Illustrates and describes methods of overcoming very steep grades. 1200 w. Cassier's Mag—March, 1910. Special No. No. 12521 D.

Rails.

Investigation of Defective Open Hearth Rails. Robert Job. From a paper read before the Am. Soc. for Test. Mat. Illustrated detailed account of research work. 1200 w. Ry Age Gaz—March 11, 1910. No. 12249.

Terminals.

Unit Movements at Terminal Stations. H. McL. Harding. Discusses the handling capacity of freight stations. 3500 w. Eng Rec—March 12, 1910. No. 12245.

The New York Terminal Extension of the Pennsylvania Railroad. The Terminal Station—West. B. F. Cresson, Jr. Illustrated detailed description of the station between 31st and 33d Sts., Ninth and Tenth Aves., New York City, and its construction. 11000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12655 E.

Ties.

Steel and Reinforced-Concrete Sleepers in the United States. A review of the types tried and the degree of success reached. 3000 w. Engng—March 4, 1910. No. 12288 A.

Conservation of Cross-Ties by Means of Protection from Mechanical Wear. Extracts from a paper read before the Am. Ry. Engng. & Main. of Way Assn., by J. W. Kendrick. Ills. 5000 w. Ry & Engng Rev—March 19, 1910. No. 12383.

Protection of Cross-Ties from Mechanical Wear by Means of Plugs, Screw Spikes and Tie Plates with Estimates of Costs and Savings. J. W. Kendrick. Extracts from a paper read before the Am. Ry. Engng & Main. of Way Assn. 3000 w. Engng-Con—March 30, 1910. No. 12768.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Track Construction.

Track Construction in the Detroit River Tunnel. Brief illustrated description of a special type of track construction. 700 w. Eng Rec—March 5, 1910. No. 12147.

Track Maintenance.

The Economics of Railroad Maintenance of Way. W. M. Cunningham. Gives an outline of railway maintenance, with tables showing relative cost, explaining the policy of the better roads. 4000 w. Jour of Acc—March, 1910. No. 12300 C.

Transfer Bridges.

The Oak Point Float Bridges on the East River. Illustrated description of double-track suspended bridges, operated by electricity. 3000 w. Eng Rec—March 12, 1910. No. 12242.

Tunnels.

See Track Construction, under PERMANENT WAY AND BUILDINGS.

Water Supply.

See E. P. and S. Railway, under CIVIL ENGINEERING, WATER SUPPLY.

TRAFFIC.

Car Interchange.

The American Railway Clearing House. Arthur Hale. Paper prepared at the request of the Committee on Clearing House Settlements of the Soc. of Ry. Financial Officers. Explains the methods and work, giving the history of the undertaking. 3000 w. Ry Age Gaz—March 11, 1910. No. 12250.

Explosives.

Promotion of Safety in the Transportation of Explosives and Other Dangerous Articles in the United States. Col. B. W. Dunn. Describes past and present methods used on railroads, and explains the origin, organization and work of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles. Ills. 6000 w. Jour Fr Inst—March, 1910. No. 12748 D.

Freight.

See Terminals, under PERMANENT WAY AND BUILDINGS.

Freight Handling.

The Cost of Terminal Freight Handling in the Port of New York. A brief criticism of the terminal methods at this port, with suggestions for their improvement. 1000 w. Eng News—March 31, 1910. No. 12775.

Freight Rates.

The Western Freight-Rate Situation. Samuel O. Dunn. From an article in *Scribner's Mag.* 1200 w. Ry. Age Gaz—March 25, 1910. No. 12640.

MISCELLANY.

Africa.

Railway and Engineering Progress in Africa. J. Hartley Knight. A review of engineering achievements and opportunities, and the demand for power, machinery and equipment. Ills. 2500 w. Engineering Magazine—April, 1910. No. 12681 B.

Forestry.

Forestry Work of the A., T. & S. F. Ry. Illustrated description of the eucalyptus grove in southern California. 5000 w. Ry & Engng Rev—March 12, 1910. No. 12264.

France.

Transportation and Traffic in France. Logan G. McPherson. Historical review.

We supply copies of these articles. See page 317.

9000 w. Ry Age Gaz—March 11, 1910. No. 12251.

Natal.

See Construction, under PERMANENT WAY AND BUILDINGS.

Pennsylvania R. R.

Pennsylvania Railroad. Editorial review of the financial and business condition, earnings, expenses, etc. Map. 2200 w. Ry Age Gaz—March 11, 1910. No. 12248.

Taxation.

The Need of Uniform Railway Taxation. Charles Hansel. Explains present conditions in the United States and the difficulty of remedying the methods of taxation employed. 1500 w. Ry Age Gaz—March 25, 1910. No. 12641.

Transandine Railroad.

The Trans-Andine Railroad Completed. Thaddeus S. Dayton. Information concerning the new railroad over the Andes connecting Valparaiso and Buenos Aires. 1500 w. Ir Age—March 17, 1910. No. 12302.

STREET AND ELECTRIC RAILWAYS.

Car Wheels.

Cast-Iron and Steel Wheels Discussed at Hartford. Paper by F. A. Beebe, with discussion. The paper was an answer to practical questions submitted in advance. Ills. 2000 w. Elec Ry Jour—March 12, 1910. No. 12223.

Conduit Rails.

Reinforcement of Conduit Rails at Washington. Philander Betts. Illustrated description of the work with some figures regarding its cost. 1000 w. Elec Ry Jour—March 12, 1910. No. 12222.

Electric Traction.

Electric Railway Problems. J. G. Pertsch. Explains method and applications of graphical integration and differentiation in solving train movement problems. 2500 w. Sib Jour of Engng—March, 1910. Serial. 1st part. No. 12553 C.

Locomotives.

The Development and Design of the Electric Locomotive. Theodore Rich. Illustrated review of the development of electric traction on railways. 5000 w. Cassier's Mag—March, 1910. Special No. No. 12515 D.

Modern Developments in Heavy Locomotives. C. L. de Muralt. Deals especially with trunk line electrification and heavy electric locomotives. 3500 w. Jour Worcester Poly Inst—March, 1910. No. 12323 C

The New "Pennsylvania" Locomotives. George Gibbs. Information concerning the locomotives for the N. Y. terminal extension of the Penn. R. R. Ills. 1000 w. Yale Sci M—March, 1910. No. 12647 C.

Milwaukee, Wis.

Improving the Street Railway Service at Milwaukee, Wis.; the Result of an Investigation by the Wisconsin Railroad Commission. Describes the investigation made. 3000 w. Eng News—March 24, 1910. No. 12588.

Monorail.

The Function of the Gyroscope in Monorail Cars (Die Wirkungsweise der Kreisel im Einschienenwagen). Herr Bolstorff. A discussion and criticism of the Scherl system. Ills. 3800 w. Glasers Ann—Feb. 15, 1910. No. 12484 D.

Municipal Control.

Methods of Municipal Control and Regulation of the Chicago Street Railways. Brief account of the history of the street railway franchises and systems of Chicago, with a summary of the principal provisions of the settlement ordinances. 4000 w. Eng News—March 10, 1910. No. 12213.

New York City.

Development of the New Metropolitan Street Railway. An account of the changes made during the receivership through which the lines have passed. 3500 w. Elec Ry Jour—March 26, 1910. No. 12651.

Power Conversion.

Changing an Interurban Electric Railway from Alternating to Direct-Current Operation. Explains the cause of the change and shows the general scheme of the 1200-volt d. c. system. 1500 w. Eng News—March 3, 1910. No. 12111.

Shops.

Tramway Repair Works and Machinery. C. Pendlebury. An illustrated discussion of maintenance of electric tramway equipment. 2500 w. Cassier's Mag—March, 1910. Special No. No. 12519 D.

Subways.

A New Subway Line for New York City; Its History. Reviews the history of the new triborough subway. Map. 3500 w. Eng News—March 10, 1910. No. 12218.

Kearney High-Speed Railway. Brief illustrated description of a new single-tube electric system. 1000 w. Elec Engr, Lond—March 11, 1910. No. 12386 A.

Trunk Lines.

The Economics of Electric Trunk-Line Operation (Ueber die Wirtschaftlichkeit der elektrischen Vollbahnen). Herr Fränkel. A general discussion. 5500 w. Glasers Ann—Feb. 15, 1910. No. 12483 D.

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EXPLANATORY NOTE—THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Building Materials.

Introduction to the Chemistry and Physics of Building Materials. By Alan E. Munby. Size, 8 by 6 in.; pp., xx, 345. Ills. Price, $2. New York: D. Van Nostrand Company.

A general and elementary treatment of the subject, designed to enable persons without knowledge of chemical and physical science to appreciate something of the principles which underlie the use of building materials. The first part of the book deals with the principles of physics, chemistry and geology which have a direct bearing on the production, use and decay of materials. In the second part these principles are applied to the study of stones, brick clays, limes and cements, the metals, timber, and paints. The author has attempted to do little more than generalize. For detailed information he refers the reader to the standard works on the individual subjects; but within the limits of treatment he has set he has produced a useful guide to the employment and preservation of building materials.

Gas Turbines.

The Gas Turbine. By Henry Harrison Suplee. Size, 9 by 6 in.; pp., 262. Ills. Price, $3. Philadelphia: J. B. Lippincott Company.

A summary of such theoretical and practical data as are now available in the solution of the problem of the gas turbine, most of which have already been published in the transactions of societies or in technical periodicals. Introductory chapters on the early development of gas-turbine theory are followed by reprints of R. M. Neilson's paper before the Institution of Mechanical Engineers in 1904, and M. L. Sekutowicz's paper before the Société des Ingenieurs Civils de France in 1906, with the discussions they elicited. A chapter on the actual behavior of gases in nozzles describes the experiments of Dr. Charles E. Lucke, and the practical work of Armengaud and Lemale is described in detail. In a brief concluding chapter Mr. Suplee draws general conclusions as to the possibility of making the gas turbine a commercial machine.

Metallurgical Appliances.

The Mechanical Appliances of the Chemical and Metallurgical Industries. By Oskar Nagel. Size, 9 by 6 in.; pp., 307. Ills. Price, $2, 8/6. New York: Published by the Author.

A review of all the prominent types of machines which are of interest to the industrial chemist and metallurgist, with detailed descriptions of the leading representatives of each type. The first section of the book discusses the generation, transmission and utilization of steam, water, gas and electric power as employed in the chemical and metallurgical industries. This is followed by a study of methods and appliances for the transportation of solids, liquids and gases. The remaining chapters are devoted to grinding and mixing machines, firing and furnaces, separating, the purification of gases, evaporating, distilling and condensing, drying appliances, and the measurement of temperature.

Petroleum Mining.

Petroleum Mining and Oil-Field Development. By A. Beebe Thompson. Size, 9 by 6 in.; pp., xx, 362. Ills. Price, $5. New York: D. Van Nostrand Company; London: Crosby Lockwood & Son.

A guide to the exploration of petroleum lands, and a study of the engineering problems connected with the winning of petroleum. The chapter headings are: Introductory; Geological Structure and Petrographical Character of Petroleum Fields, and their Bearing upon the Distribution of Petroleum in the Strata; Indications of Petroleum and Phenomena Associated with its Occurrence; Origin, Composition, Characteristics, and Treatment of Petroleum; Systems of Drilling or Boring for Petroleum and Natural Gas; Casing or Lining Tubes for Oil Wells, and Appliances Employed in Connection with its Insertion, Extraction and Repairs; Exclusion of Water from Oil Wells; the Extraction of Petroleum and Natural Gas; Sources of Energy in Oil Fields; the Combustion of Liquid Fuel; and the Measurement, Collection, Transmission, and Utilisation of Natural Gas.

Sheet-Metal Work.

Practical Sheet and Plate Metal Work. By Evan A. Atkins. Size, 7½ by 5 in.; pp., 491. Ills. Price, $2. New York and London: Whittaker & Co.

A practical book for the sheet-metal worker, the outcome of a series of articles contributed to the *English Mechanic*. Practical methods of laying out patterns for all classes of sheet and plate work are described in detail, with a large number of very clear illustrations. Hints are given as to allowances for joints, wiring and notches, bending up, use of tools, etc. Chapters are included dealing with the surface treatment and properties of metals, mensuration rules, and sheet and plate metal working machines and tools. Besides being of distinct value to the mechanic who desires to become a more expert craftsman, the book should serve as a useful work of reference for works managers and draughtsmen.

BOOKS RECEIVED.

Rust Prevention. By L. M. Stern. Size, 8 by 5½ in.; pp., 54. Ills. Cleveland, O.: Published by the Author.

Metal Spinning. By Prof. Fred D. Crawshaw. Size, 7 by 5 in.; pp., 72. Ills. Price, 25 cents. Chicago: Popular Mechanics Co.

The A B C of Railroad Signaling. By W. H. Elliott. Size, 7 by 5 in.; pp., 75. Ills. Chicago: Mackenzie-Klink Publishing Company.

The Girl and the Motor. By Hilda Ward. Size, 7 by 5 in.; pp., 120. Ills. Price, $1. Cincinnati, O.: The Gas Engine Publishing Company.

Shaft Governors. By Hubert E. Collins. Size, 7 by 5 in.; pp., 127. Ills. Price, $1. New York and London: Hill Publishing Company.

Chaudières Marines et Accessoires. By L. Jauch and A. Masméjean. With 37 plates. Size, 10 by 6½ in.; pp., 521. Ills. Price, 22 Fr. Toulon: J. Alté.

Pumps: Troubles and Remedies. By Hubert E. Collins. Size, 7 by 5 in.; pp., 99. Ills. Price, $1. New York and London: Hill Publishing Company.

Practical Calculation of Transmission Lines. By L. W. Rosenthal. Size, 9 by 6 in.; pp., 93. Ills. Price, $2. New York: McGraw Publishing Company.

Suction Gas Plants. By C. Alfred Smith. Size, 8 by 5 in.; pp., 198. Ills. Price, $1.75. Philadelphia: J. B. Lippincott Company; London: Charles Griffin & Co.

The Portland Cement Industry from a Financial Standpoint. By Edwin C. Eckel. Size, 9 by 6 in.; pp., 93. Ills. Price, $2. New York: Moody's Magazine.

Artificial Waterways and Commercial Development. By A. Barton Hepburn. Size, 7½ by 5 in.; pp., 115. Price, $1. New York: The Macmillan Company.

Heat Energy and Fuels. By Hanns v. Jüptner. Translated by Oskar Nagel. Size, 9 by 6 in.; pp., 306. Ills. Price, $3. New York: McGraw Publishing Company.

Law and Business of Engineering and Contracting. By Charles Evan Fowler. Size, 9 x 6 in.; pp., 162. Ills. Price, $2.50. New York: McGraw Publishing Company.

Handbook for Field Geologists. By C. W. Hayes. Size, 7 by 5 in.; pp., ix, 159. Ills. Price, $1.50, 6/6. New York: John Wiley & Sons; London: Chapman & Hall.

The Temperature-Entropy Diagram. By Charles W. Berry. Size, 7½ by 5 in.; pp., xviii, 209. Ills. Price, $2, 8/6. New York: John Wiley & Sons; London: Chapman & Hall.

Tables for Calculating Sizes of Steam Pipes for Low-Pressure Heating. By Isaac Chaimovitsch. Size, 7 by 5 in.; pp., 47. Ills. Price, $2. Chicago: Domestic Engineering.

Smoke Prevention and Fuel Economy. By Wm. H. Booth and John B. C. Kershaw. Size, 8½ by 5½ in.; pp., 194. Ills. Price, $2.50. New York: The Norman W. Henley Publishing Co.

Hydraulic Tables. By Gardner S. Williams and Allen Hazen. Second Edition. Size, 9 by 6 in.; pp., 104. Price, $1.50, 6/6. New York: John Wiley & Sons; London: Chapman & Hall.

The Deposition of Alexander Graham Bell in the Suit brought by the United States to Annul the Bell Patents. Size, 9 by 6 in.; pp., 469. Ills. Boston: American Bell Telephone Company.

Die Herstellung von Hochprozentigem Ferrosilizium im elektrischen Ofen. By Waldemar Pick and Walter Conrad. Size, 9½ by 6½ in.; pp., 144. Ills. Price, M 6.60. Halle a. S.: Wilhelm Knapp.

Oil Motors: their Development, Construction, and Management. By G. Lieckfeld. Size, 9 by 6 in.; pp., xv, 272. Ills. 306. Price, $4.50. Philadelphia: J. B. Lippincott Company; London: Charles Griffin & Co.

The Mechanical Engineering of Steam Power Plants. By Frederic Remsen Hutton. Third Edition. Size, 9 by 6 in.; pp., xli, 825. Ills. Price, $5, 21/-. New York: John Wiley & Sons; London: Chapman & Hall.

The Theory and Practice of Bridge Construction in Timber, Iron and Steel. By Morgan W. Davies. Size, 7½ by 5 in.; pp., 504. Ills. Price, $3.75. New York: The Macmillan Company; London: Macmillan & Co.

Lecture Notes on the Theory of Electrical Measurements. By William A. Anthony. Third Edition, revised by Albert Ball. Size, 7½ by 5 in.; pp., ix, 122. Ills. Price, $1, 4/6. New York: John Wiley & Sons; London: Chapman & Hall.

A Text-Book of Mechanical Drawing and Elementary Machine Design. By John S. Reid and David Reid. Second Edition. Size, 9 by 6 in.; pp., xxi, 438. Ills., 329. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.